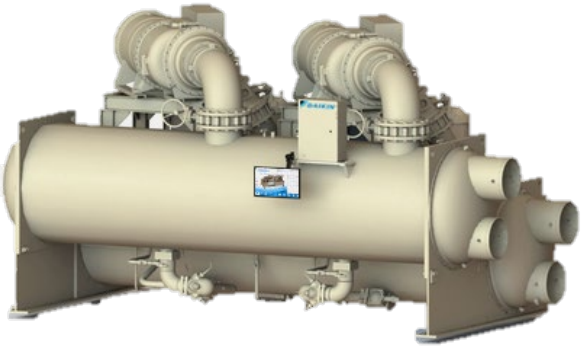
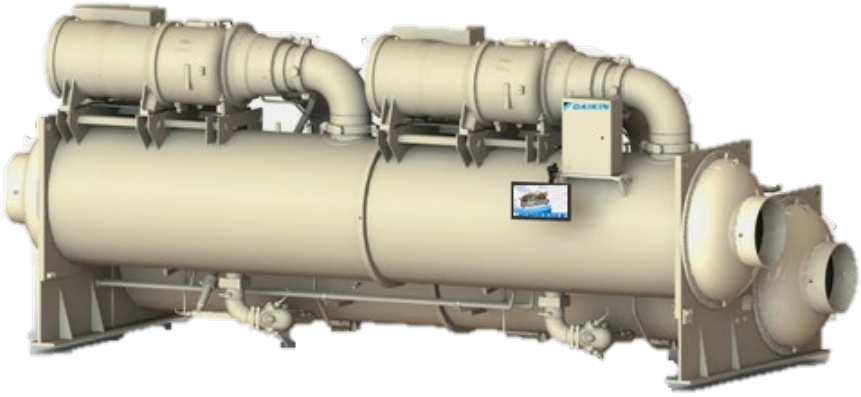

WSC (300 – 1,800 Tons)

WDC (600 – 2,500 Tons)



WCC (1000 – 2,700 Tons)



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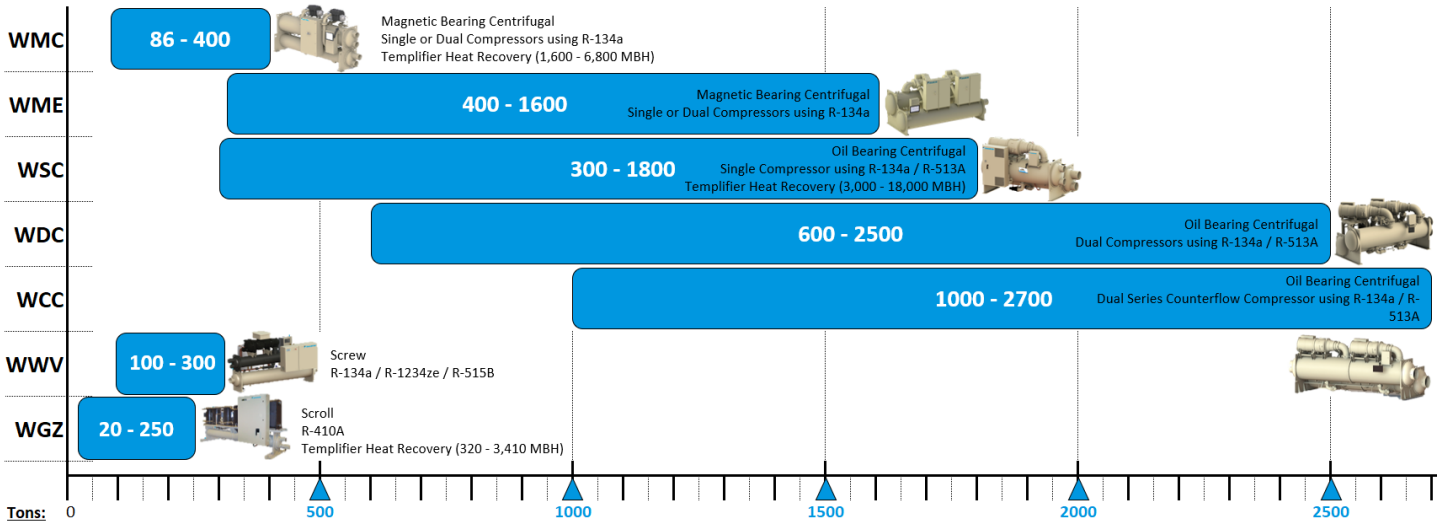
Choosing the Right Daikin Water-Cooled Chiller for Your Job

1. **Determining Which Product Line to Bid:** Daikin offers several products within its water-cooled chiller portfolio including oil-free magnetic bearing centrifugals (WMC and WME), traditional oiled centrifugals (WSC, WDC, and WCC), screws (WWV), and scrolls (WGZ). See the below water-cooled product portfolio for water-cooled offerings at Daikin for available capacity ranges:



It's not only important to consider how many tons of cooling your chiller requires for the project, but it's also critical to understand the product's capabilities. For example, if your customer requires 200 tons capacity, you could consider bidding WMC, WWV, or WGZ. However, all three of those products have completely different price points, efficiency values, dimensions, and overall technology/compressor designs. You may even find different products offer different lead times, maintenance, and refrigerant usages. See below table to use as a cheat sheet:

	WMC	WME	WSC	WDC	WCC	WWV	WGZ
Capacity (tons)	86 – 400	401 – 1600	300 – 1800	600 – 2500	1000 – 2700	100 – 300	20 – 250
Chiller Category (Compressor Type)	Oil-Free Magnetic Bearing Centrifugal	Oil-Free Magnetic Bearing Centrifugal	Traditional Oiled Centrifugal	Traditional Oiled Dual Centrifugal	Traditional Oiled Dual Series Counterflow Centrifugal	Screw	Scroll
Redundancy? (Compressor Qty)	Yes (1-2)	Yes (1-2)	No (1)	Yes (2)	Yes (2)	No (1)	Yes (1-6)
Refrigerants Available	R-134a, R-513A	R-134a, R-513A	R-134a	R-134a	R-134a	R-134a	R-410A
Market Price	$$$$	$$$$	$$	$$$	$$$	$$	$
Best Full Load Eff. @ AHRI Conditions	0.54 kW/ton	0.52 kW/ton	0.54 kW/ton	0.55 kW/ton	0.52 kW/ton	0.58 kW/ton	0.74 kW/ton
Best Part Load Eff. @ AHRI Conditions	0.31 kW/ton	0.30 kW/ton	0.32 kW/ton	0.33 kW/ton	0.35 kW/ton	0.36 kW/ton	0.57 kW/ton
Starter Options	VFD	VFD	SSS, VFD, ATL, AT, No Starter	SSS, VFD, ATL, AT, No Starter	SSS, VFD, ATL, AT, No Starter	VFD	ACL

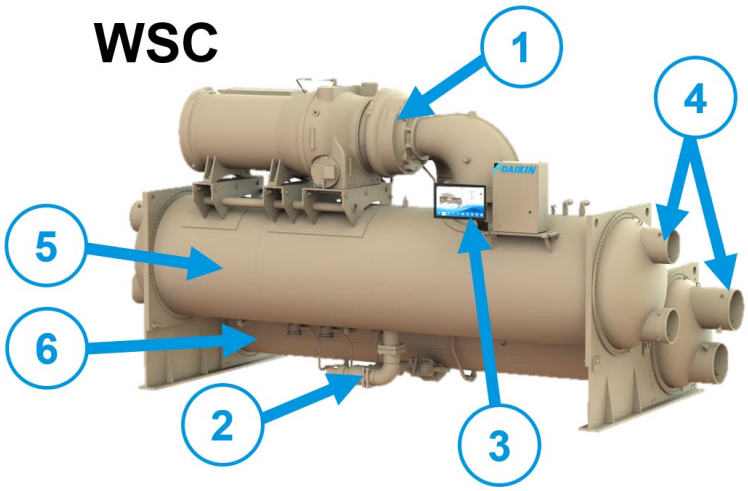
See next page for best Daikin water-cooled product line bidding strategies:

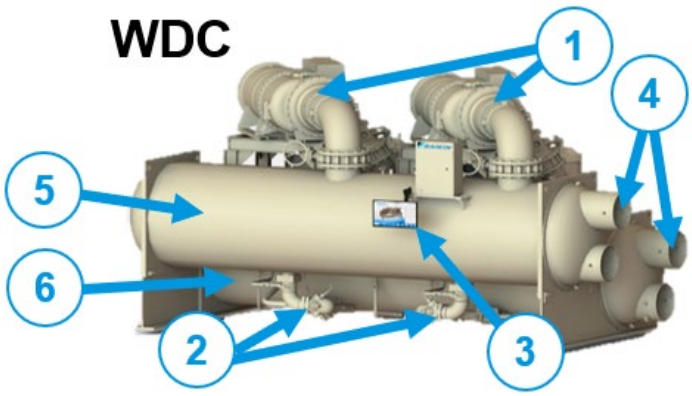
Tonnage	Daikin Water-Cooled Chiller Positioning for Projects at AHRI Conditions
20 – 100	(1) Bid **WGZ** (scroll)
100 – 250	(1) Bid **WWV** (screw) for value-oriented customers seeking improved performance or high lift applications (2) Bid **WGZ** (scroll) for lowest first cost, & less customer concern with efficiency (3) Bid **WMC** (magnetic bearing centrifugal) for best performance and sustainable oil-free operation
250 – 300	(1) Bid **WWV** (screw) for value-oriented customers seeking good performance or high lift applications (2) Bid **WMC** (magnetic bearing centrifugal) for best performance and sustainable oil-free operation
300 – 400	(1) Prioritize pushing the project towards **WMC** (magnetic bearing centrifugal) for best performance, smaller footprint, & industry-leading mission critical RapidRestore® & RideThrough® features (2) Consider **WSC** (traditional oiled centrifugal) as a backup/alternate bid if the customer requires lower first cost or more voltage options
400 – 800	(1) Prioritize pushing the project towards **WME** (magnetic bearing centrifugal) for best performance (push single compressor in this range) & industry-leading mission critical RapidRestore & RideThrough (2) Consider **WSC** (traditional oiled centrifugal) as a backup/alternate bid if the customer requires lower first cost or more voltage options – WME & WSC have similar footprint
800 – 1,200	(1) Prioritize pushing the project towards **WME** (magnetic bearing centrifugal) for best performance, reliable dual compressor redundancy, & industry-leading mission critical RapidRestore & RideThrough (2) Consider **WSC** (traditional oiled centrifugal) as a backup/alternate bid if the customer requires lower first cost or more voltage options – WME & WSC have similar footprint (3) Additionally, **WDC** is the only oiled dual centrifugal on the market that offers redundancy under 1,500 Tons & has great unloading with small footprint, so getting this specified could be a way to spec out the competition for an easy win
1,200 – 1,600	(1) Try to first push the project towards **WME** (magnetic bearing centrifugal) for best performance, reliable dual compressor redundancy, & industry-leading mission critical RapidRestore & RideThrough features, while considering **WSC** (traditional oiled centrifugal) as a backup/alternate bid if the customer requires lower first cost or more voltage options – WME & WSC have similar footprint (2) Additionally, **WDC** & **WCC** are the only oiled dual centrifugals on the market that offer redundancy under 1,500 Tons, so getting one of these specified could be a way to spec out the competition for an easy win – WDC offers better part load performance with great unloading & smaller footprint than WCC, whereas WCC is only available with 1 pass nozzle arrangements but offers better full load performance & high chilled water ΔT with low pressure drops
1,600 – 1,800	(1) Prioritize bidding **WSC** as much as possible for lowest first cost in this capacity range (2) Bid either **WDC** or **WCC** (both oiled dual centrifugals) if redundancy is required – WDC offers better part load performance with great unloading & smaller footprint than WCC, whereas WCC is only available with 1 pass nozzle arrangements but offers better full load performance & high chilled water ΔT with low pressure drops
1,800 – 2,300	(1) Bid either **WDC** or **WCC** (both oiled dual centrifugals) – WDC offers better part load performance with great unloading & smaller footprint than WCC, whereas WCC is only available with 1 pass nozzle arrangements but offers better full load performance & high chilled water ΔT with low pressure drops
Above 2,300 (Multi-Unit Systems Approach)	(1) Bid multiple **WDC** (oiled dual centrifugal) units in parallel piping arrangement if smaller footprint & low energy consumption with best part load performance is desired due to unloading instead of cycling chillers ON/OFF (2) Bid multiple **WCC** (oiled dual centrifugal) units (only available with 1 pass nozzle arrangements) in series counterflow piping arrangement if project requires low energy consumption at full load with high electrical demand charges due to cycling chillers ON/OFF instead of unloading individual chillers high chilled water ΔT with low pressure drops (3) Bid a combination of **WDC + WCC** if peak overall system efficiency is priority – WCC units can cycle ON/OFF, while the WDC unit with VFDs can trim the load down to 5% capacity per unit (4) If each unit can be smaller in capacity, bid either multiple low voltage **WME** (magnetic bearing centrifugal) units in series counterflow piping arrangement for best performance, & industry-leading mission critical RapidRestore & RideThrough features, or bid multiple **WSC** (traditional oiled centrifugal) units in series counterflow piping arrangement for lower first cost or more voltage options – WME and WSC have similar footprint

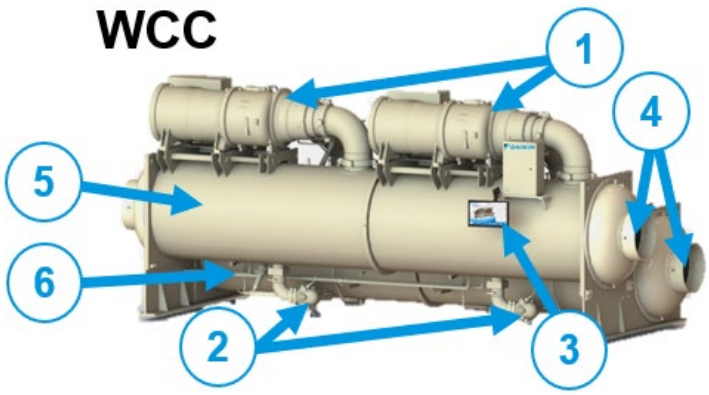
Traditional Oiled Centrifugal Chillers Overview

1. **Product Description:** WSC, WDC, and WCC chillers all utilize traditional oiled centrifugal technology on a water-cooled platform, but each offers differences in design, capacity range, application, redundancy, and more. WSC offers 300-1800 tons with only one compressor, WDC offers redundancy in its 600-2500 tons capacity range using two compressors in parallel, and WCC incorporates a series counterflow design using two refrigerant circuits with its two compressors to achieve 1000-2700 tons. All three product lines are offered with medium pressure refrigerant R-134a. Generally, traditional oiled centrifugal designs are more competitive over magnetic bearing chillers when it comes to first cost, but lifecycle costs usually indicate the payback is worth paying a premium for the magnetic bearing products if available in your desired tonnage. See our Magnitude® Sales Playbook for more details. From a component perspective, the main difference between WSC, WDC, and WCC lies in the number of compressors and overall chiller design. WSC, WDC, and WCC offer an air-cooled VFD as well as other fixed speed starters – see below for details:

Item #	WSC, WDC, & WCC Components
1	Oiled Bearing Centrifugal Compressor
2	Electronic Expansion Valve(s)
3	Touchscreen, Movable HMI (Control Panel)
4	Nozzles (WCC only allows 1 pass arrangement)
5	Evaporator Shell w/ Compact Waterboxes Standard (Marine Optional)
6	Condenser Shell w/ Compact Waterboxes Standard (Marine Optional)







2. **Capabilities Overview:** When ambient wet bulb temps are lower than design, the condenser entering water temps (EWT) of WSC, WDC, and WCC chillers can be lowered to improve chiller performance, able to start and run with condenser EWT as low as 55 F. However, using the lowest possible condenser EWT could be more expensive in total system power consumed than expected savings in chiller power would suggest, depending on local climate conditions, due to excessive fan power required. The tradeoff between better chiller efficiency and fan power should be analyzed for best overall system efficiency. The Energy Analyzer™ program can optimize the chiller/tower operation for specific buildings and locations. Generally, a 1 F drop in ECWT reduces chiller energy consumption by 2% since cooler tower water lowers condensing pressure and thus compressor work.

   Additionally, WDC and WCC dual compressor units can provide up to 60% of their full load capacity in case one compressor fails, whereas single compressor competitors require a compressor teardown to replace with a spare that must be purchased and stored at on site, leading to massive downtime. Also note in the table seismic certifications received for your seismically critical applications or certain geographic locations. WSC and WDC are certified with IBC and California OSPHD (HCAI) – this should offer peace of mind knowing that even during earthquakes, Daikin chillers will continue to function properly; up-to-date seismic certifications can be found at: https://hcai.ca.gov/construction-finance/preapproval-programs/oshpd-special-seismic-certification-preapproval-osp/. Key design features for WSC, WDC, and WCC include the use of impeller liquid injection at discharge and non-contacting hydrodynamic sleeve bearings with effectively infinite life and movable discharge geometry for excellent unloading with moderate sound levels. Dimensionally, WSC, WDC, and WCC offer compact configurations, making them ideal for retrofit applications, where facility space limitations exist. For the same capacity, WDC offers smaller footprint than WCC with its 16 ft long vessels to minimize unit length. There are also several knockdown shipment options available to select for your specific application. See the DST program for model-specific dimensions.

	WSC	WDC	WCC
Key Benefits & Ideal Applications	Good overall performance w/ optional unit mounted Starter/VFD & Heat Recovery/Templifier™ (HSC/TSC) at relatively lower first cost	Great part load performance & compressor redundancy ideal for unloading – 1, 2, or 3 pass nozzle arrangements available w/ short vessels (compact footprint)	Great full load performance & compressor redundancy ideal for cycling the unit ON/OFF to reduce system capacity & high chilled water ΔT w/ low press drop – 1 pass nozzle arrangement only, ideal for using WCC's in SCF to maximize performance
Capacity Achieved Under 1 Compressor Failure	0%	60% of full load	50% of full load
Tons (# of Compressors)	300 – 1800 (1)	600 – 2500 (1)	1000 – 2700 (1)
Compressor	Traditional Oiled Centrifugal	Traditional Oiled Dual Centrifugal	Traditional Oiled Dual Series Counterflow Centrifugal
Starter/Drive Options	Air-Cooled VFD, SSS, ATL, AT, No Starter	Air-Cooled VFD, SSS, ATL, AT, No Starter	Air-Cooled VFD, SSS, ATL, AT, No Starter
Full Load Efficiency	0.54 kW/ton	0.55 kW/ton	0.52 kW/ton
Part Load Efficiency	0.32 kW/ton	0.33 kW/ton	0.35 kW/ton
Min Condenser EWT	Below 55 F	Below 55 F	Below 55 F
Max Evaporator LWT	Above 70 F	Above 70 F	Above 70 F
Minimum Load	Below 20%	Below 20%	Below 20%
Compressor Stages	1	1	1
# of Refrigerant Circuits	1	1	2
AHRI Sound Levels (SPLA)	83 – 88 dBA	86 – 92 dBA	89 – 103 dBA
Seismic Certification	S_{DS} = 1.6g @ z/h = 1 S_{DS} = 1.6g @ z/h = 0	S_{DS} = 1.6g @ z/h = 1 S_{DS} = 1.6g @ z/h = 0	N/A
Shell Length (w/out WB)	12 – 16 ft	16 – 20 ft	20 ft
Total Unit Width	6.0 – 8.7 ft	4.8 – 9.0 ft	6.7 – 10.3 ft
Total Unit Height	6.5 – 10.3 ft	7.7 – 9.8 ft	8.3 – 10.0 ft

3. **Zero Tolerance & Testing:** Sometimes specifications call for testing of their purchased chillers to tolerances more stringent than those under AHRI 550/590 standard. A zero tolerance (ZT) rating suggests that a measured value will be equal to or exceed the associated published value. For chillers, it's a way of ensuring the unit can deliver the requested capacity and/or efficiency at the design flow of the evaporator and condenser. ZT options should be principally utilized at the request of the customer. Whether or not ZT performance values need to be furnished should be detailed in the specification. What may be omitted is upon which values ZT should be applied, i.e. which of the three options, or another unavailable in the software, should be utilized. The result of providing performance data based on the wrong option could be profound, resulting in a lost sale or selling an underrated chiller.

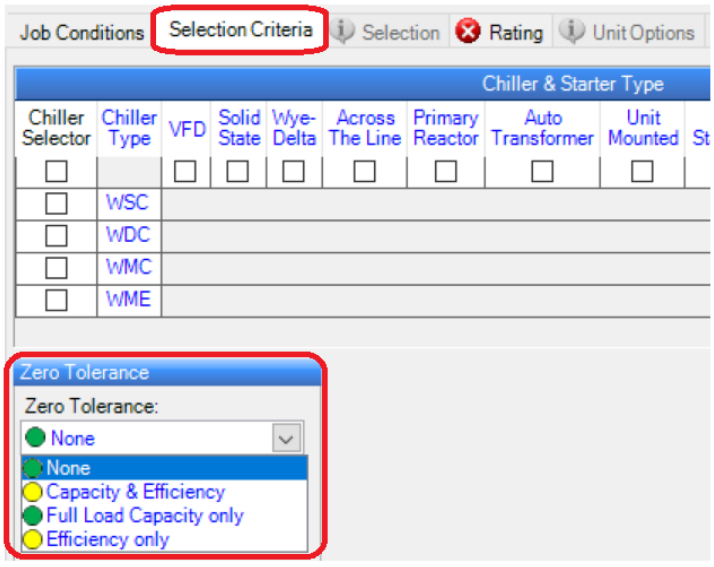
Recent DST software enhancements allow the user to select another unit that meets the capacity requirements brought about by the non-standard tolerance requirement. The current process requires the Sales Rep to input the job conditions as usual, and then there is an option in the "Selection Criteria" tab called "Zero Tolerance" option (see below screenshot for reference). Make sure you select the right type of special tolerance needed and then select the points required for ZT submission to export the file to Chiller Applications team, or contact the team for any questions on verbiage in your specification. ZT is only applied to capacity and efficiency values. All other values including, but not limited to, temperature, flow, pressure drop, RLA, supply voltage, supply frequency, and heat balance are calculated based on AHRI 550/590 standards. Measured power input kW (absolute) is not guaranteed to meet the predicted value, but the resultant kW/ton value is. DST Centrifugal Chiller offers the following ZT options:

- **Capacity and Efficiency:** Chiller capacity is guaranteed exactly at or above its design capacity when operating at full load conditions, while chiller efficiency is guaranteed exactly at or better than its design efficiency for all requested load points.

- **Full Load Capacity Only:** Chiller capacity is guaranteed to perform exactly at or above its design capacity when operating at full load conditions.

- **Efficiency Only:** Normal AHRI tolerance exists for capacity, while chiller efficiency is guaranteed exactly at or better than its design efficiency for all requested load points.

It's important to note at this time that when a ZT option is specified, the performance displayed on-screen is the same as when "None" is specified. For actual performance with your chosen ZT option, please contact Chiller Applications. While placing the order, FPA must be entered for any special tolerance performance.



4. **Refrigerants:** At this time, we confidently promote using R-134a as the best A1 (low toxicity, non-flammable) refrigerant available for medium pressure chillers. There is currently no production phase out date for HFCs and therefore little concern about R-134a availability over the useful life of Daikin Chillers. EPA SNAP Rules 20 and 21 proposed the ban of R-410A, R-134a, and R-407C refrigerants as components of *new chillers* shipped *after* January 1, 2024. This does not ban manufacture of HFC refrigerants, but rather bans shipments of new chillers using those refrigerants after that date. R-134a is largely used on the plastic foam blowing and pharma industries, so it will be available for the life of chillers purchased today from recycled/reclaimed sources.

New refrigerants have emerged as possible alternatives to R-134a, such as R-513A. This is a lower GWP alternative to R-134a (570 versus 1300), however R-513A comes with a 3% efficiency penalty at full load design conditions. To best prepare for the future, take an inventory of the refrigerant types your HVAC systems uses, determine which, if any, are being phased out, and recommend replacement alternatives. Consider the proactive approach: require that new equipment use "green" refrigerants so the equipment you buy today can be supported for its useful life.

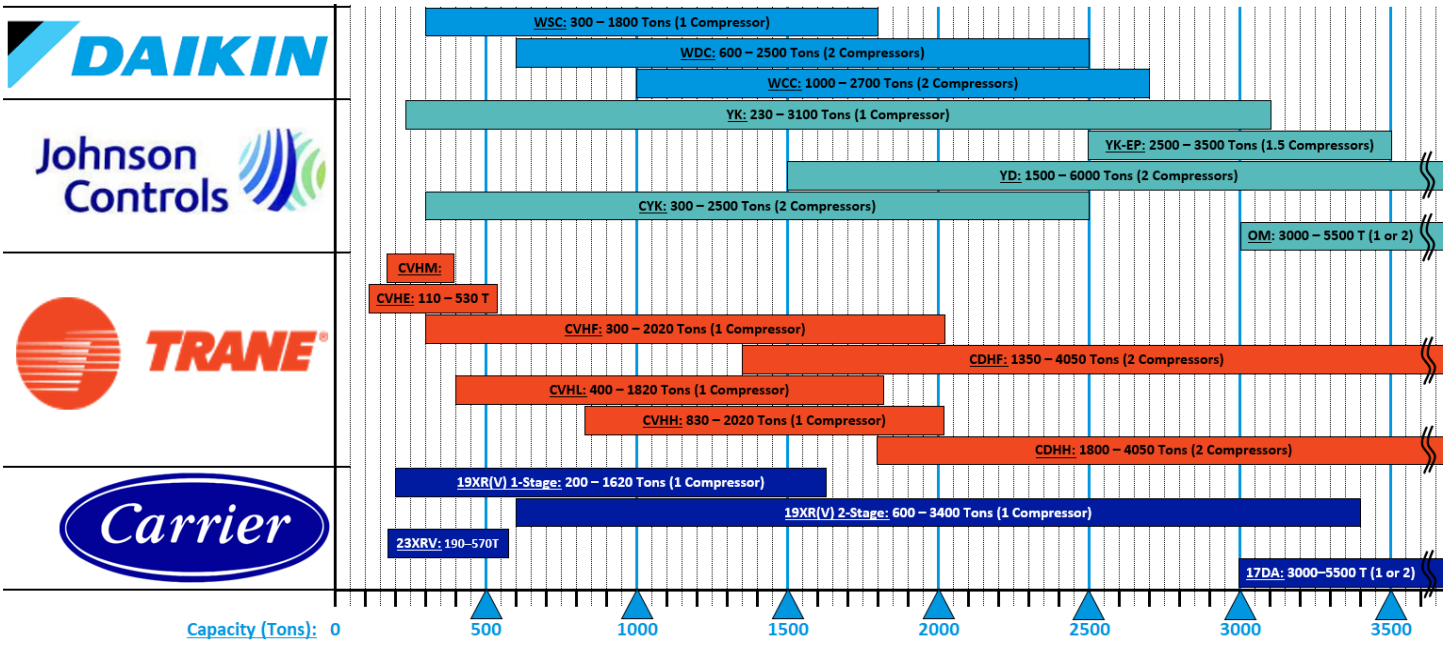
Total Equivalent Warming Impact (TEWI) is a combination of the refrigerant GWP, unit refrigerant emissions rate, and the refrigeration system's energy efficiency. All engineers agree that a systems approach is necessary to evaluate the real effect of a substance on global warming. In a chiller, the contribution of the GWP is *insignificant* when compared to the effect of a unit's power needs translated to power plant CO2 emissions. Due to its thermal properties, R-513A hurts chiller efficiency, which in turn causes more TEWI. Bottom line: equipment operators should keep equipment leak free and operate as efficiently as possible. The next generation of refrigerants is coming, and Daikin will be ready. In the meantime, Daikin is fully committed to offering Chillers with R-134a and confident that the refrigerant will be available throughout the lifetime of any new chiller purchased. Sticking with R-134a won't increase your operational costs and will be a viable refrigerant choice for years to come. For more information, see the Refrigerants Playbook: https://sales.daikinapplied.com/CMSWebParts/Daikin/DocDownloader.ashx?dnp=/operations/Marketing/Assets/Media/Daikin_Applied_Sales_Playbook_-_Refrigerants.pdf

Refrigerant	Type	Composition	Pressure / Purge Unit	Unit Size	Toxicity – Flammability	GWP_{100} (AR_4)	ODP	Efficiency	Capacity
R-134a Medium Pressure Alternate Refrigerants (Centrifugal & Screw Compressors)									
R-134a	HFC	Pure 100% R-134a	Medium (+) / No	S	A-1	1430	0		
R-513A	HFC/HFO	44% R-134a / 56% R-1234yf	Medium (+) / No	S	A-1	631	0		
R-1234ze(E)	HFO	Pure 100% R-1234ze(E)	Medium (+) / No	M	A-2L	1	0		
R-515B	HFO/HFC	91.1% R-1234ze(E) / 8.9% R-227ea	Medium (+) / No	M	A-1	293	0		
R-123 Low Pressure Alternate Refrigerants (Centrifugal Compressors)									
R-123	HCFC	Pure 100% R-123	Low (–) / Yes	XL	B-1	77	0.02		
R-1233zd(E)	HFO	Pure 100% R-1233zd(E)	Very Low (–) / Yes	L	A-1	1	0		
R-514A	HFO	74.7% R-1336mzz / 25.3% R-1130	Low (–) / Yes	XL	B-1	2	0		
R-410A High Pressure Alternate Refrigerants (Scroll Compressors, Commercial DX, Residential)									
R-410A	HFC	50% R-32 / 50% R-125	High (+) / No	M	A-1	2088	0		
R-32	HFC	Pure 100% R-32	High (+) / No	S	A-2L	675	0		
R-454B	HFC/HFO	68.9% R-32 / 31.1% R-1234yf	High (+) / No	M	A-2L	466	0		
R-466A	HFC	49% R-32 / 39.5% CF3I / 11.5% R-125	High (+) / No	M	A-1	733	0		

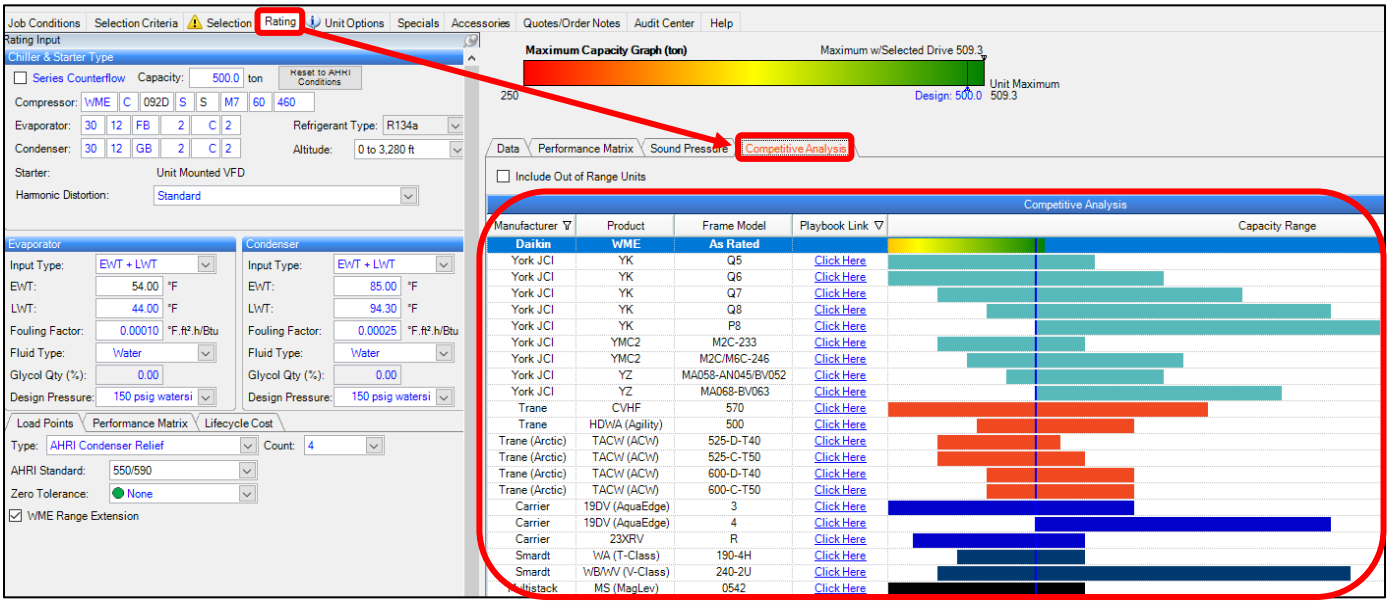
5. **Harmonics:** The topic of harmonics often comes up regarding variable speed drives (or VFDs), where VFD's came about decades ago, with a more recent importance put on harmonics. The first VFDs were revolutionary but came with side effects in the form of sinusoidal current line waveform distortions, now referred to as "harmonics." In sensitive applications or ones containing lots of electrical equipment (hospitals, datacenters, etc.), harmonics not only distort outgoing power to the utility company, but also disturb other equipment on site. Once it was discovered that VFDs were to blame for the unknown issues, VFD technology has since drastically improved and the need for further reduction of these harmonics has greatly diminished. IEEE 519 standard was created as a means to set values and limits to allowable distortion of the power signal returning from a given customer site. While vital to maintain a standard of quality on the incoming and returning power circulated between a utility transformer, the standard also gave rise to several misconceptions that have been further propagated by some chiller manufacturers in their own financial interest (they have a price advantage to do so versus other manufacturers) by pushing benefits of active harmonic filtering or expensive 18-24 pulse VFDs. IEEE 519 calculations are done so at a system wide level (point of common coupling), the point at which one utility customer's neighbor can access the power leaving another customer's facility rather than individual chiller terminals. Chiller and plant-wide specifications are often prepared with goal to minimize harmonic interference or simply comply with IEEE 519. This topic is often misunderstood, thus overly stringent requirements are set, resulting in wasted money on unnecessary electrical equipment.

   So is harmonic filtering necessary? It's hard to say definitively, as the need for such equipment varies based on application and geographical considerations. IEEE 519 requirements vary based on facility size versus amount of power available per transformer. What's important is minimizing harmonic distortion at the system level, at the point of common coupling (total distortion in current line leaving facility). We see many specifications calling for 5% max distortion at a given chiller's terminals, rather than at the system level. We generally recommend pushing back against this specification, as it ends up being far more stringent than any possible IEEE 519 requirement. Most VFDs today include some type of technology to mitigate injection of harmonics to begin with such as line reactors, DC chokes, improved 12/18/24-pulse designs, options for add on filtration, or 6-pulse VFD with line reactor. In some cases, adding on a cost-effective passive filter can be beneficial, but active filtration or large 18-24-pulse drives are costly and overkill in all but the most sensitive environments. Engage your customer here as early as possible to avoid wasting money on unnecessary equipment. If they're uneasy, propose an optional upstream filter following installation if any issues arise – these can be purchased through a third party or Daikin.

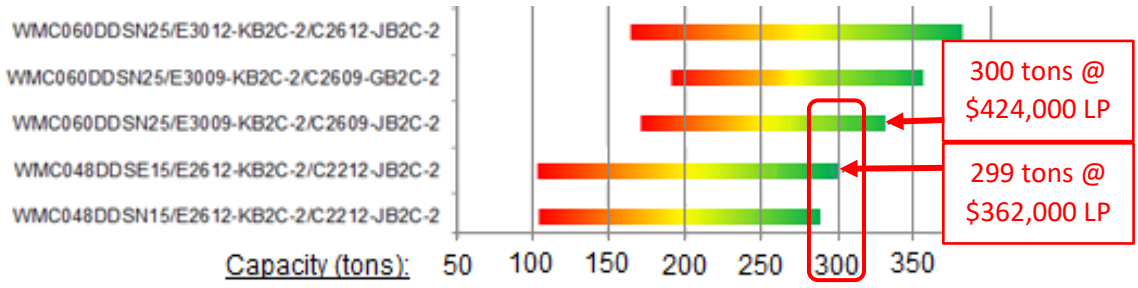
1. **Oiled Centrifugal Chillers Landscape:** See below graph by Product Line: Tonnage (# of Compressors)



2. **Model Nomenclature/Framebreak:** Understanding what model a competitor is using to determine that competitor's frame size is a powerful sales strategy. Once model frames are understood, important information regarding that model's capacity limits, dimensions, and sometimes price can be determined. Your goal should be to position your Daikin chiller at the top of the frame towards the right (green portion of the colorful capacity graph shown in DST below), while other competitors are on a frame size in the bottom or middle areas (red/yellow colored section below). See below where to find this "Competitor Analysis" tab information in DST:



If you are Basis of Design on a project, make sure to select the optimum capacity sweet spot to be at a price advantage. For example, see below chart showing the difference one model size can make in price. The model that makes 300 tons has a list price of 424,000 versus the 299 ton model at 362,000. This means that just a 0.3% difference in capacity would give us a price advantage of nearly 15% and typically has smaller unit dimensions too. Note the chart below is for reference only, as the model numbers, capacity values, and list prices themselves are not up-to-date – consult the Chiller Applications Team for help with these sweet spots for your project.



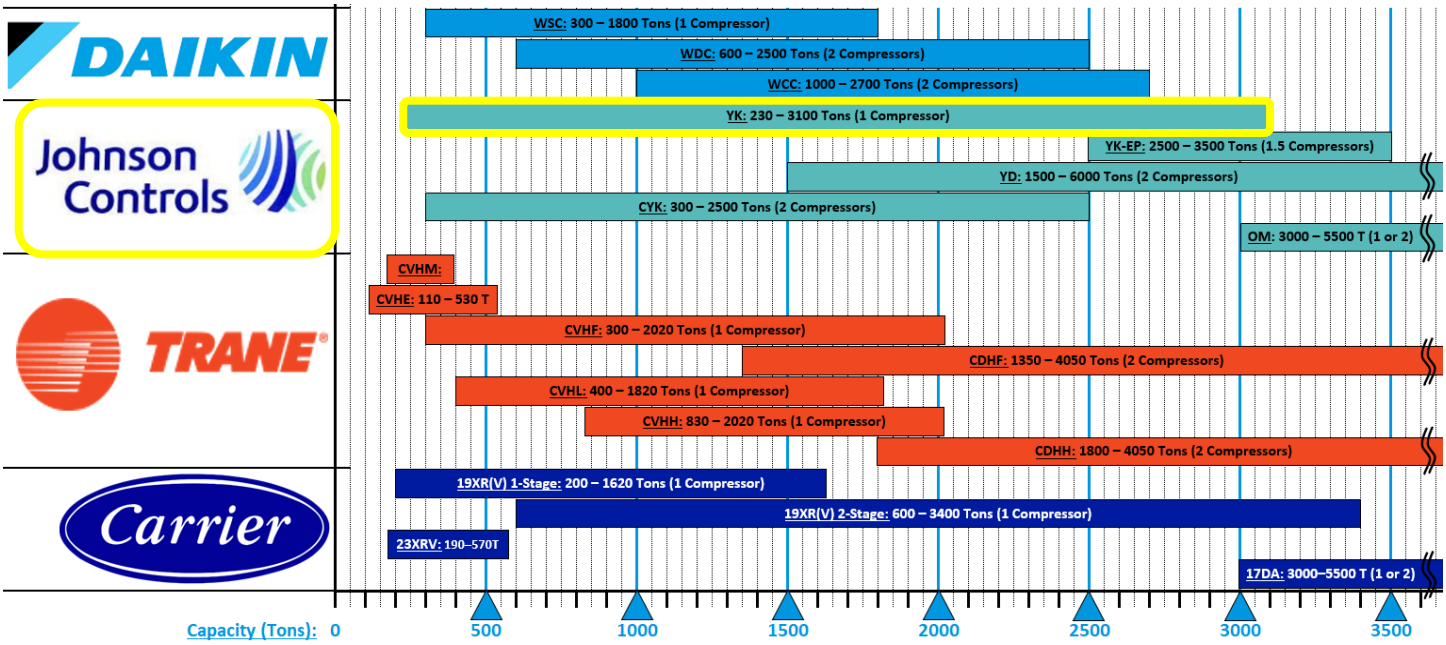
See the "Sales Strategies (SS)" section further down in this Playbook for how to determine competitor frame size.

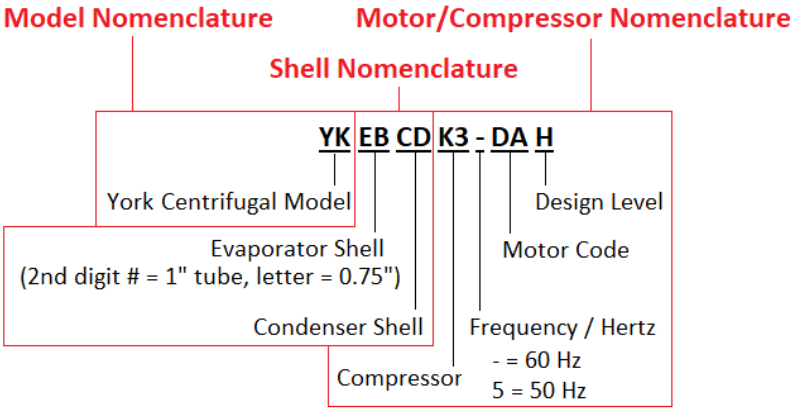
3. **Competitive Capabilities Overview:** It's interesting to see similarities and differences between the various oiled centrifugal chiller models available in the market, which we can then identify advantages and weaknesses – note most characteristics of Daikin products are superior to most competitors. See below:

	DAIKIN			Johnson Controls			TRANE		Carrier		
	WSC	**WDC**	**WCC**	**YK**	**YK-EP**	**YD**	**CVHM/E/F/H**	**CDHF/H**	**19XRV (1)**	**19XRV (2)**	**23XRV**
(# of Compressors) Tonnage Range	(1) 300-1800	(2) 600-2500	(2) 1000-2700	(1) 230-3100	(1.5) 2500-3500	(2) 1500-6000	(1) 120-2020	(2) 1350-4050	(1) 200-1620	(1) 600-3400	(1) 190-570
Refrigerant(s)	134a	134a	134a	134a, 513A, 1234ze(E)	134a, 513A	134a, 513A	CVHM/E/F: 514A (Toxic) CVHH: 1233zd(E)	CDHF: 514A (Toxic) CDHH: 1233zd(E)	134a, 513A	134a, 513A	134a
Chiller Type	Centrifugal: Oiled	Centrifugal: Dual Oiled	Centrifugal: Series Counterflow Dual Oiled	Centrifugal: Oiled	Centrifugal: Series Counterflow Dual Oiled	Centrifugal: Dual Oiled	Centrifugal: Oiled	Centrifugal: Series Counterflow Dual Oiled	Centrifugal: Oiled	Centrifugal: Oiled	Screw: Oiled
Compressor / Motor	1-Stage Semi-Hermetic, Gear Driven	1-Stage Semi-Hermetic, Gear Driven	1-Stage Semi-Hermetic, Gear Driven	1-Stage Open-Drive, Gear Driven	1-Stage Open-Drive, Gear Driven	1-Stage Open-Drive, Gear Driven	2/3-Stage Semi-Hermetic, Direct Driven	2-Stage Semi-Hermetic, Direct Driven	1-Stage Semi-Hermetic, Gear Driven	2-Stage Semi-Hermetic, Gear Driven	N/A Semi-Hermetic, Direct Driven
VFD Cooling	Air	Air	Air	Fouled Cond Water	Fouled Cond Water	Fouled Cond Water	Refrigerant or Air	Refrigerant	Refrigerant	Refrigerant	Refrigerant or Air
Best Full Load kW/ton	0.54	0.55	0.52	0.52	0.51	0.53	0.48 – 0.52	0.49	0.54	0.53	0.53
Best Part Load kW/ton w/VFD	0.32	0.33	0.35	0.32	0.33	0.33	0.30 – 0.33	0.31	0.32	0.33	0.30
Footprint per Ton	Small	Small	Small	Small	Small	Small	Large	Large	Small	Small	Small
Typical Sound Levels (dBA)	83 – 88	86 – 92	89 – 103	80 – 86	84 – 90	82 – 88	75 – 83	85 – 93	86 – 89	85 – 88	83 – 86
Seismic (S_{DS}) Certification	1.6@z/h=1; 1.6@z/h=0	1.6@z/h=1; 1.6@z/h=0	N/A@z/h=1; N/A@z/h=0	1.85@z/h=1; 2.5@z/h=0	N/A@z/h=1; N/A@z/h=0	N/A@z/h=1; N/A@z/h=0	N/A–1.45 @z/h=1; N/A–2.28 @z/h=0	N/A@z/h=1; N/A@z/h=0	N/A@z/h=1; N/A@z/h=0	N/A@z/h=1; N/A@z/h=0	2.0@z/h=1; 2.5@z/h=0
Maintenance	$	$	$	$	$	$	$$	$$	$	$	$$$
First Cost	$	$	$	$	$	$	$$	$$	$	$	$
Market Coverage	Good	Good	Good	Great	Great	Great	Great	Great	Poor	Poor	Poor

Sales Strategies (labeled as "(SS)" below) are most important to use and communicate before and during bidding

Johnson Controls YK





YK Framebreak Estimates at Standard AHRI Conditions				
Compressor	**Tonnage Range**	**Shell Length ***	**Unit Width**	**Unit Height**
Q3	230 - 430	12 - 16 ft	5.1 - 5.5 ft	7.0 - 7.3 ft
Q4	250 - 500	12 - 16 ft	5.2 - 7 ft	7.2 - 8.0 ft
Q5	310 - 560	12 - 16 ft	5.2 - 7 ft	7.9 - 8.3 ft
Q6	350 - 630	12 - 16 ft	5.2 - 7 ft	7.9 - 8.3 ft
Q7	400 - 710	12 - 16 ft	6.2 - 7.2 ft	8.1 - 8.7 ft
Q8	450 - 800	12 - 16 ft	6.2 - 7.2 ft	8.3 - 9.5 ft
P7/P8	500 - 850	12 - 16 ft	6.9 - 7.5 ft	9.5 - 10.9 ft
P9	570 - 950	12 - 16 ft	6.9 - 7.5 ft	9.5 - 10.9 ft
H9	700 - 1,200	14 ft	7.5 - 8.8 ft	9.5 - 10.9 ft
K1	850 - 1,500	14 - 16 ft	8.1 - 9.7 ft	9.6 - 11.5 ft
K2	1,000 - 1,800	14 - 16 ft	9.2 - 10.1 ft	11.3 - 11.9 ft
K3	1,300 - 1,950	16 ft	9.2 - 10.3 ft	10.7 - 11.9 ft
K4	1,600 - 2,700	16 - 18 ft	10.3 - 11.9 ft	11.9 - 12.3 ft
K7/KS	2,000 - 3,100	18 - 22 ft	10.9 - 13.2 ft	12.1 - 14.1 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Product Overview: **YK** is JCI's flagship water-cooled traditional oiled centrifugal chiller, offered over a wide capacity range (230 – 3,100 Tons) and has a very high market share in the space. **YK** competes mainly with Daikin's **WSC** product line, while **WDC** and **WCC** compete less often

Design: **YK** is designed around medium (positive) pressure refrigerants R-134a, R-513A, and R-1234ze(E) using 1 stage of compression with 1 refrigerant circuit and no economizer option

Sound: **YK's** noise levels (SPLA) range from 80 – 86 dBA

Performance: **YK** offers good (but not best-in-class) performance with full load efficiency of 0.52 kW/Ton and part load IPLV of 0.32 kW/Ton

Starters/Drives: **YK** uses a liquid (fouled condenser water) cooled unit mounted low voltage VFD with active harmonic filter (5% THD) up to 1,800 Tons and fixed speed starters along with VFDs offered in low, medium, and high voltages

(SS) Specify air-cooled or refrigerant-cooled VFD, or if condenser water is supplied, the manufacturer shall supply factory installed dual water filters with a bypass valve and pressure differential switch factory wired to the chiller control panel to indicate that a filter has clogged and requires service. The pressure differential switch shall also provide a separate dry contact which can be connected to the BAS system as a means of notifying operating personnel of the need to service the filters

Redundancy: **YK** does not offer redundancy with its single compressor design, but starting at 1,500 Tons up to 6,000 Tons, the "dual **YK**" product line called the "**YD**" is available

(SS) Pushing your project towards redundancy with dual compressor chillers below 1,500 tons could be a good strategy (**WMC**, **WME**, **WDC**, **WCC**)

Seismic: **YK's** seismic certifications are as follows: S_{DS} = 1.85 @ z/h = 1 (roof height) and S_{DS} = 2.5 @ z/h = 0 (ground)

Compressor-Motor: **YK** uses an air-cooled, open-drive (non-hermetic), gear-driven motor, yielding higher maintenance costs

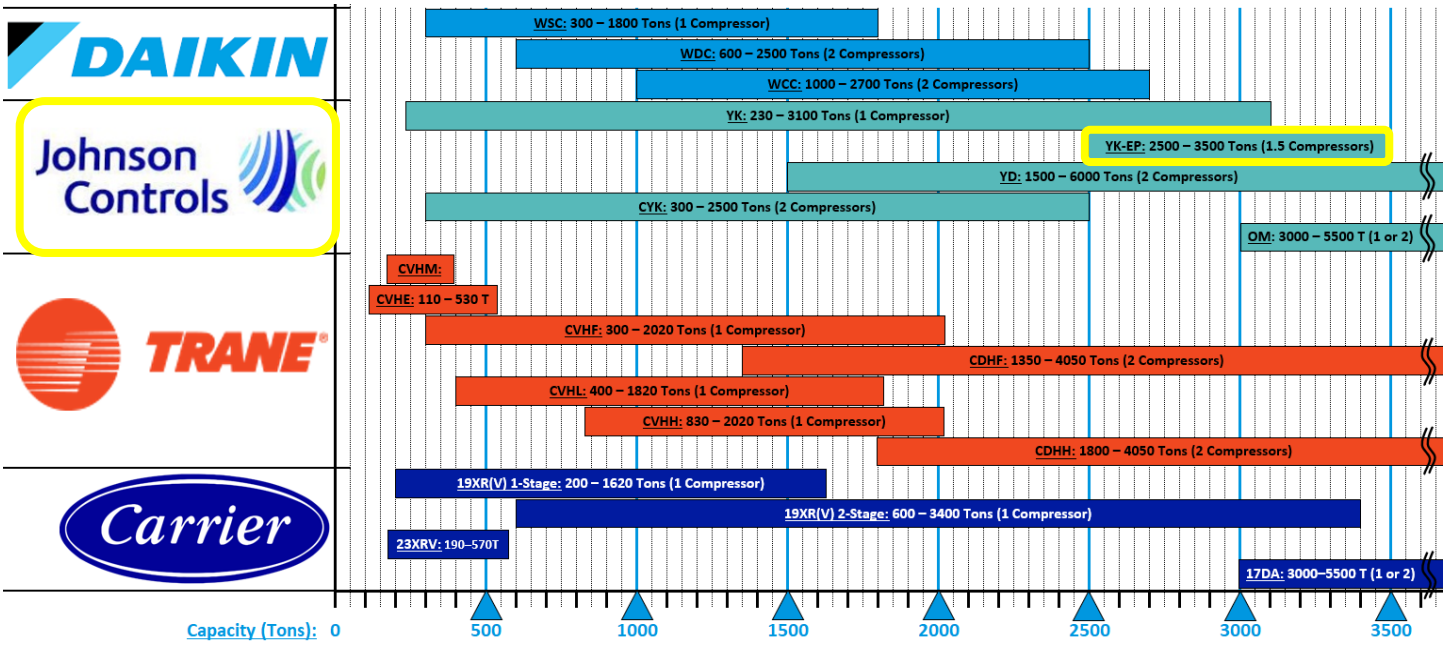
(SS) Air-cooled (open-drive, non-hermetic) motors expel additional heat into the surrounding environment, therefore separate AHUs or other cooling mechanisms may be required in your customer's mechanical room. Specify mechanical room cooling like FCU or AHU to offset heat load to the mechanical space by specifying the chiller manufacturer shall assume all costs to supply and install a self-contained air conditioning system in the mechanical space sized to handle the maximum heat output of the open drive motor to compensate for the heat added to the equipment room. The energy required to operate this air conditioning system shall be added to the chiller power at all rating points for energy evaluation purposes

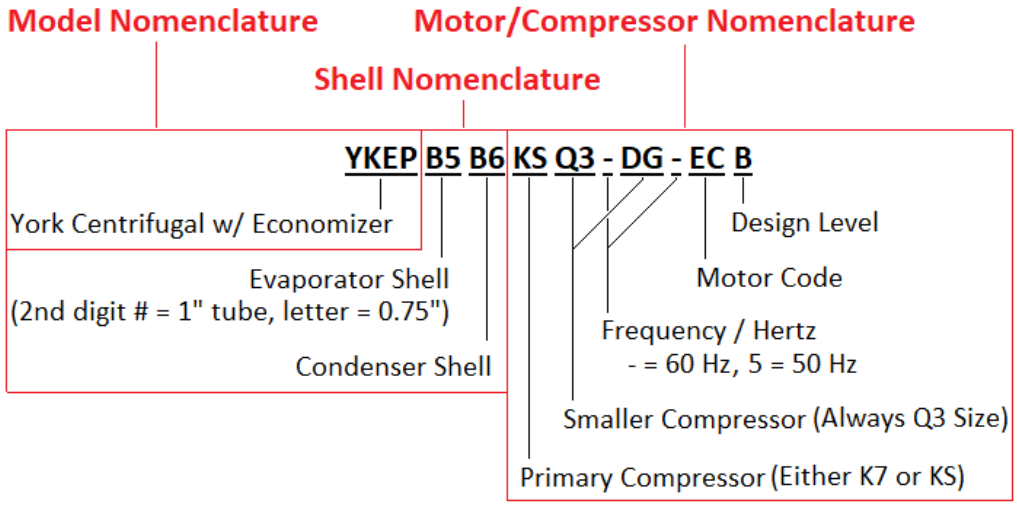
Footprint: **YK** has a somewhat compact footprint – Daikin's same capacity **WSC**, **WDC**, and **WCC** chillers are similar or smaller in size

(SS) Highlight the importance of optimizing floorspace at your customer's facility when Daikin has a footprint advantage, especially ideal for retrofit applications

Sales Strategies (labeled as "(SS)" below) are most important to use and communicate before and during bidding

Johnson Controls YK-EP





YK-EP Framebreak Estimates at Standard AHRI Conditions				
Compressor	**Tonnage Range**	**Shell Length ***	**Unit Width**	**Unit Height**
K7-Q3/KS-Q3	2,500 - 3,500	22 ft	12.1 - 14 ft	12.7 - 14.4 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Product Overview: **YK-EP** is a water-cooled traditional oiled dual series counterflow centrifugal chiller – it's essentially a **YK** chiller using its largest compressor (K7 or KS) with a smaller compressor (Q3) attached in a series counterflow unit design through an economized cycle to perform half lift in parallel. **YK-EP** is offered in a higher capacity, but smaller range – note **YK's** Framebreak table shown previously indicates its K7 or KS compressor goes up to around 3,100 Tons while its Q3 compressor goes up to around 400 Tons, thus adding them up yields **YK-EP's** maximum capacity of 3,500 Tons with a lower limit of around 2,500 Tons. **YK-EP** is overall not sold much (majority of its sales are seen in Middle East and Asia markets, but is occasionally used in North America), and competes mainly with Daikin's **WCC** product line

Design: **YK-EP** is designed around medium (positive) pressure refrigerants R-134a and R-513A using 1 stage of compression for each compressor with 1 refrigerant circuit and a standard economizer

Sound: **YK-EP's** sound levels range from 84 – 90 dBA

Performance: **YK-EP** offers good (but not best-in-class) performance with full load efficiency of 0.51 kW/Ton and part load IPLV of 0.33 kW/Ton

Starters/Drives: **YK-EP** is only offered in medium or high voltages with either unit mounted Solid State Starter or floor mounted liquid (fouled condenser water) cooled VFDs with active harmonic filter (5% THD)

(SS) Specify air-cooled or refrigerant-cooled VFD, or if condenser water is supplied, the manufacturer shall supply factory installed dual water filters with a bypass valve and pressure differential switch factory wired to the chiller control panel to indicate that a filter has clogged and requires service. The pressure differential switch shall also provide a separate dry contact which can be connected to the BAS system as a means of notifying operating personnel of the need to service the filters

Redundancy: **YK-EP** does not offer redundancy even though it has two compressors (one primary compressor and one smaller compressor), but starting at 1,500 Tons up to 6,000 Tons the "dual **YK**" product line called the "**YD**" is available

(SS) Pushing your project towards redundancy with dual compressor chillers below 1,500 tons could be a good strategy (WMC, WME, WDC, WCC)

Seismic: **YK-EP** does not offer any seismic certifications – S_{DS} = N/A @ z/h = 1 (roof height) and S_{DS} = N/A @ z/h = 0 (ground)

(SS) Daikin **WSC** and **WDC** chillers are certified to S_{DS} = 1.6 @ z/h = 1 (roof height) and S_{DS} = 1.6 @ z/h = 0 (ground) which is advantageous over **YK-EP** chillers for seismically critical applications or in certain geographic locations. Contact Chiller Applications to discuss seismic specifications before quoting – updated seismic docs can be found at: https://hcai.ca.gov/construction-finance/preapproval-programs/oshpd-special-seismic-certification-preapproval-osp/

Compressor-Motor: **YK-EP** uses an air-cooled, open-drive (non-hermetic), gear-driven motor, yielding higher maintenance costs

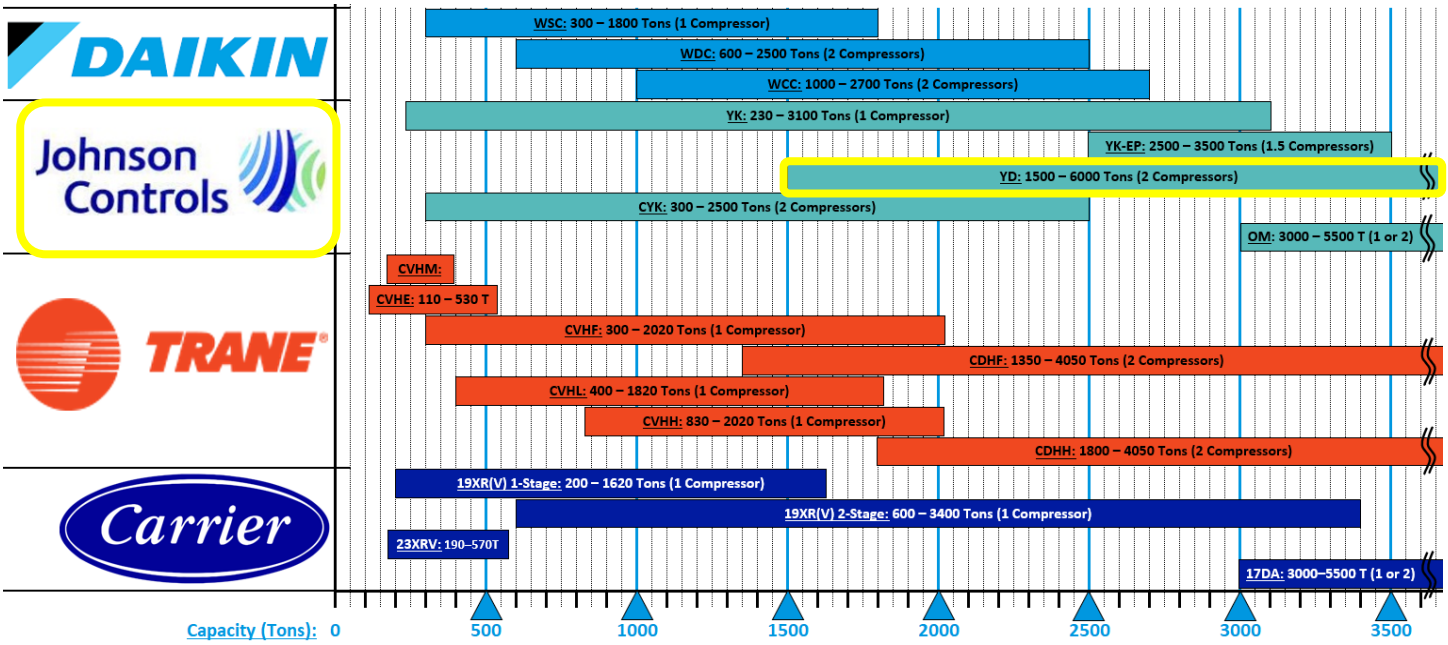
(SS) Air-cooled (open-drive, non-hermetic) motors expel additional heat into the surrounding environment, therefore separate AHUs or other cooling mechanisms may be required in your customer's mechanical room. Specify mechanical room cooling like FCU or AHU to offset heat load to the mechanical space by specifying the chiller manufacturer shall assume all costs to supply and install a self-contained air conditioning system in the mechanical space sized to handle the maximum heat output of the open drive motor to compensate for the heat added to the equipment room. The energy required to operate this air conditioning system shall be added to the chiller power at all rating points for energy evaluation purposes

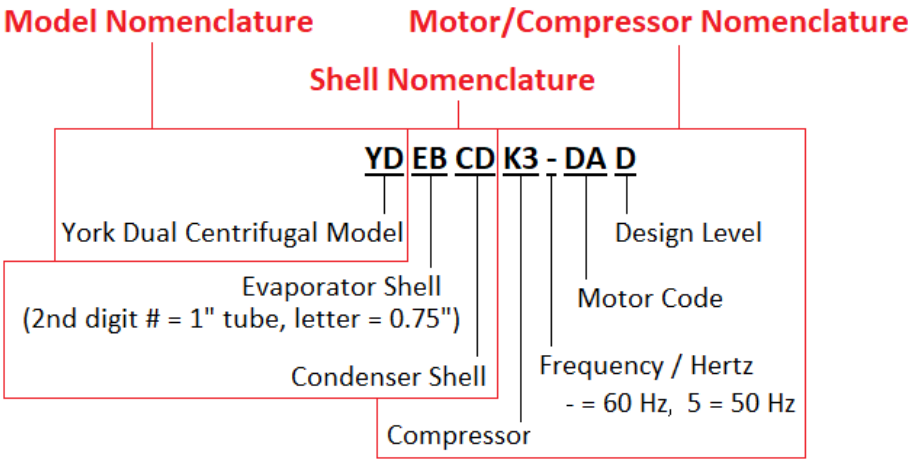
Footprint: **YK-EP** does not have a compact footprint – Daikin's same capacity **WCC** chillers are smaller in size

(SS) Highlight the importance of optimizing floorspace at your customer's facility when Daikin has a footprint advantage, especially ideal for retrofit applications

Sales Strategies (labeled as "(SS)" below) are most important to use and communicate before and during bidding

Johnson Controls YD





YD Framebreak Estimates at Standard AHRI Conditions				
Compressor	**Tonnage Range**	**Shell Length ***	**Unit Width**	**Unit Height**
H9	1,500 - 2,200	16 ft	13.3 - 13.5 ft	12 - 12.3 ft
K1	1,600 - 2,650	18 ft	13.9 ft	12.4 ft
K2	1,800 - 3,150	18 - 22 ft	13.9 - 14.3 ft	12.4 - 12.8 ft
K3	2,400 - 4,050	18 - 22 ft	16 - 16.8 ft	13.5 - 14.3 ft
K4	3,000 - 5,050	18 - 22 ft	16.8 ft	14.3 - 14.8 ft
K7	4,100 - 6,000	22 ft	18.3 ft	15 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Product Overview: **YD** is a water-cooled traditional oiled dual centrifugal chiller – it's essentially a **YK** chiller using two of its identical compressors in a parallel unit design, offered over a wide capacity range (1,500 – 6,000 Tons). **YD** is sold less frequently, but is ideal for large capacity projects, competing mainly with Daikin's WDC and WCC product lines

Design: **YD** is designed around medium (positive) pressure refrigerants R-134a and R-513A using 1 stage of compression with 1 refrigerant circuit and no economizer option

Sound: **YD's** sound levels range from 82 – 88 dBA

Performance: **YD** offers good (but not best-in-class) performance with full load efficiency of 0.53 kW/Ton and part load IPLV of 0.33 kW/Ton

Starters/Drives: **YD** uses liquid (fouled condenser water) cooled unit mounted low voltage VFDs with active harmonic filter (5% THD) up to 3,600 Tons and fixed speed starters along with VFDs offered in low, medium, and high voltages

- **(SS)** Specify air-cooled or refrigerant-cooled VFD, or if condenser water is supplied, the manufacturer shall supply factory installed dual water filters with a bypass valve and pressure differential switch factory wired to the chiller control panel to indicate that a filter has clogged and requires service. The pressure differential switch shall also provide a separate dry contact which can be connected to the BAS system as a means of notifying operating personnel of the need to service the filters

Redundancy: **YD** offers redundancy as standard throughout its capacity range

Seismic: **YD** does not offer any seismic certifications – S_{DS} = N/A @ z/h = 1 (roof height) and S_{DS} = N/A @ z/h = 0 (ground)

- **(SS)** Daikin **WSC** and **WDC** chillers are certified to S_{DS} = 1.6 @ z/h = 1 (roof height) and S_{DS} = 1.6 @ z/h = 0 (ground) which is advantageous over **YD** chillers for seismically critical applications or in certain geographic locations. Contact Chiller Applications to discuss seismic specifications before quoting – updated seismic docs can be found at: https://hcai.ca.gov/construction-finance/preapproval-programs/oshpd-special-seismic-certification-preapproval-osp/

Compressor-Motor: **YD** uses an air-cooled, open-drive (non-hermetic), gear-driven motor, yielding higher maintenance costs

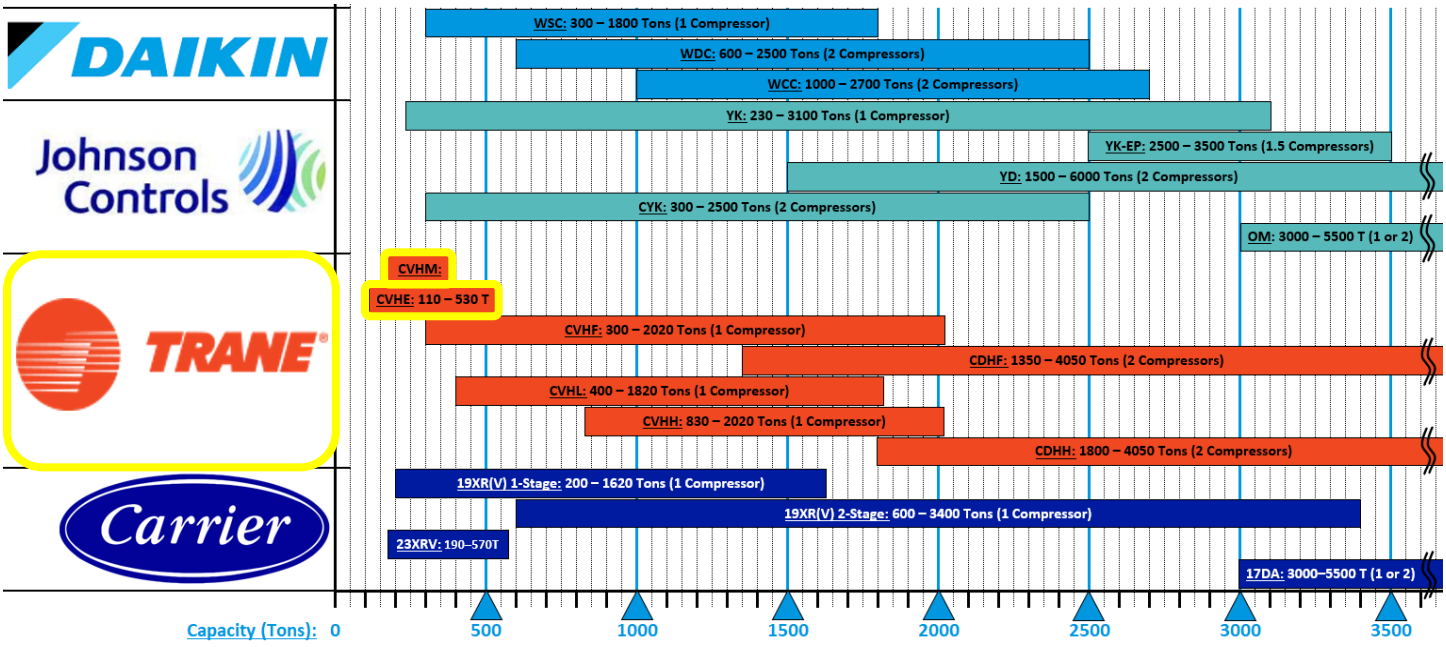
- **(SS)** Air-cooled (open-drive, non-hermetic) motors expel additional heat into the surrounding environment, therefore separate AHUs or other cooling mechanisms may be required in your customer's mechanical room. Specify mechanical room cooling like FCU or AHU to offset heat load to the mechanical space by specifying the chiller manufacturer shall assume all costs to supply and install a self-contained air conditioning system in the mechanical space sized to handle the maximum heat output of the open drive motor to compensate for the heat added to the equipment room. The energy required to operate this air conditioning system shall be added to the chiller power at all rating points for energy evaluation purposes

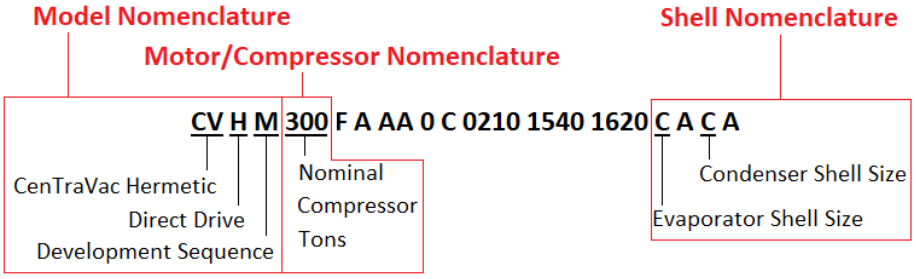
Footprint: Although JCI claims **YD** has a very compact footprint, in reality Daikin's same capacity **WSC**, **WDC**, and **WCC** chillers are smaller in size

- **(SS)** Highlight the importance of optimizing floorspace at your customer's facility when Daikin has a footprint advantage, especially ideal for retrofit applications

Sales Strategies (labeled as "(SS)" below) are most important to use and communicate before and during bidding

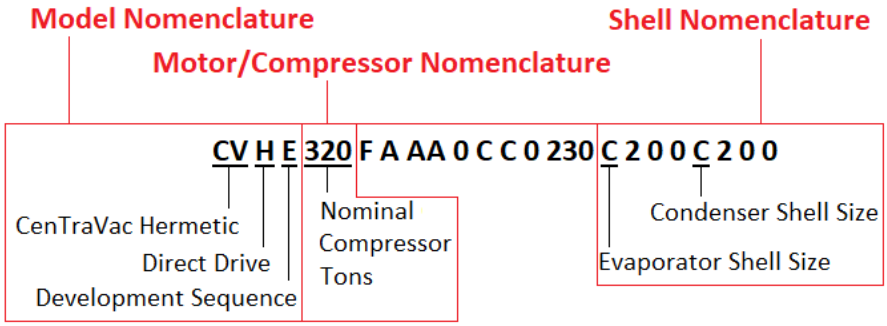
Trane CVHM / CVHE





CVHM Framebreak Estimates at Standard AHRI Conditions				
Compressor	**Tonnage Range**	**Shell Length ***	**Unit Width**	**Unit Height**
300	180 - 390	12.5 - 15 ft	7.4 ft	6.8 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.



CVHE Framebreak Estimates at Standard AHRI Conditions				
Compressor	**Tonnage Range**	**Shell Length ***	**Unit Width**	**Unit Height**
230	120 - 250	11.3 - 15 ft	5.8 - 7.8 ft	7.8 - 8.2 ft
320	190 - 340	11.3 - 15 ft	5.8 - 7.8 ft	7.8 - 8.2 ft
360	220 - 390	11.3 - 15 ft	6.7 - 9.3 ft	8.3 - 9.6 ft
450	275 - 460	11.3 - 15 ft	6.7 - 9.3 ft	8.3 - 9.6 ft
500	330 - 550	11.3 - 15 ft	6.7 - 9.3 ft	8.3 - 9.6 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Product Overview: **CVHM** and **CVHE** are both water-cooled traditional oiled centrifugal chillers, offered over a small capacity range (180 – 390 Tons for **CVHM** and 120 – 550 Tons for **CVHE**). **CVHE** is sometimes seen in the market, whereas **CVHM** is rarely seen, both competing mainly with Daikin's **WSC** product line

Design: Both **CVHM** and **CVHE** are designed around low (negative) pressure refrigerant R-514A (has high toxicity), using multistage compressors (2 stage for **CVHM,** and 3 stage for **CVHE**) with 1 refrigerant circuit and a standard economizer

(SS) Specify lower toxicity refrigerants must be used

Sound: **CVHE's** sound levels range from 75 – 79 dBA, and **CVHM's** sound levels range from 71 – 77 dBA (both are very quiet)

Performance: **CVHM** offers best-in-class performance with full load efficiency of 0.48 kW/Ton and part load IPLV of 0.30 kW/Ton, and **CVHE** offers great performance with full load efficiency of 0.50 kW/Ton and part load IPLV of 0.32 kW/Ton. Additionally, Trane sometimes pushes for 2 GPM/ton Condenser flow rate (standard is 3 GPM/ton) or high lift conditions (85/100 F in Condenser, whereas standard AHRI conditions are 85/95 F)

(SS) Straying away from AHRI conditions benefits Trane's specific two stage compressor design, but it doesn't help the customer long term. Doing a complete system analysis including pumps, cooling tower, and chiller shows that Trane's strategy is flawed – challenge any chiller schedules/specs calling for this type of approach

Starters/Drives: **CVHM** uses a refrigerant-cooled unit mounted low voltage VFD with active harmonic filter (5% THD), and **CVHE** uses a refrigerant-cooled or air-cooled unit mounted low voltage VFD with active harmonic filter (5% THD) for all capacities and fixed speed starters along with VFDs offered in low voltages

Redundancy: **CVHM** and **CVHE** do not offer redundancy, but starting around 1,400 Tons up to 4,050 Tons the "dual **CVHF**" (**CDHF**) and "dual **CVHH**" (**CDHH**) product lines are available

(SS) Pushing your project towards redundancy with dual compressor chillers below 1,400 tons could be a good strategy (**WMC**, **WME**, **WDC**, **WCC**)

Seismic: **CVHM** does not offer any seismic certifications: S_{DS} = N/A @ z/h = 1 (roof height) and S_{DS} = N/A @ z/h = 0 (ground), and **CVHE** only offers mediocre seismic certifications: S_{DS} = 1.16 @ z/h = 1 (roof height) and S_{DS} = N/A @ z/h = 0 (ground)

Compressor-Motor: **CVHM** and **CVHE** use refrigerant-cooled, semi-hermetic, direct-driven motors and roller bearings which have a finite life expectancy of L10-Rating

(SS) Specify the use of hydrodynamic bearings (which Daikin uses), or else the manufacturer is to provide lifetime parts and labor for all required periodic bearing maintenance and vibration analysis and report at startup and annually for purpose of trending bearing wear and condition

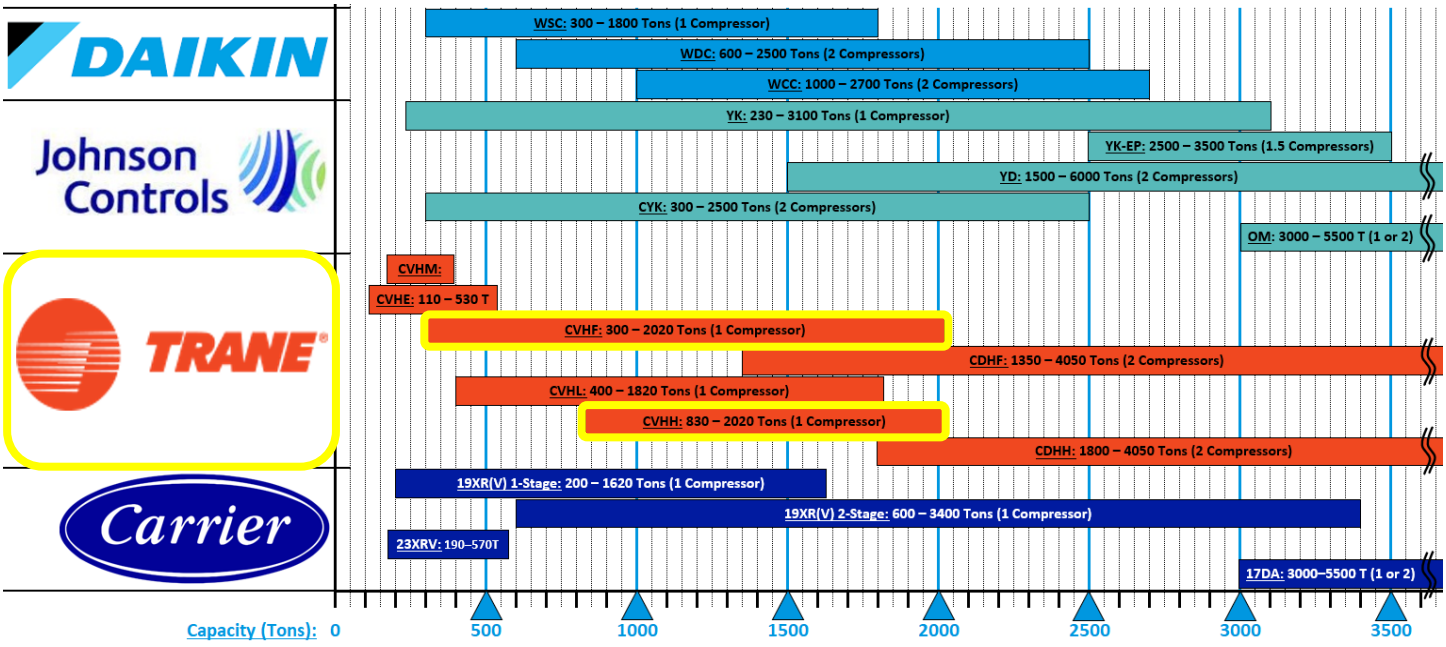
Footprint: **CVHM** and **CVHE** do not have compact footprints – Daikin's same capacity **WSC** chillers are much smaller in size

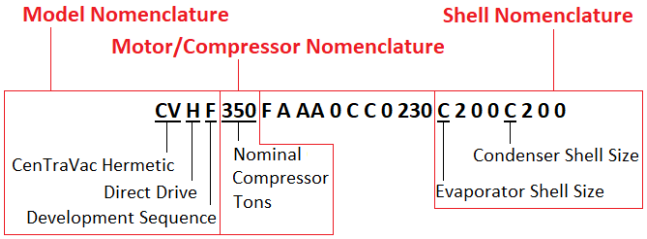
(SS) Highlight the importance of optimizing floorspace at your customer's facility to ensure Daikin has a footprint advantage, especially ideal for retrofit applications

(SS) Because of their large unit size and use of a purge unit due to being low pressure machines, these chillers are difficult and labor intensive to service

Sales Strategies (labeled as "(SS)" below) are most important to use and communicate before and during bidding

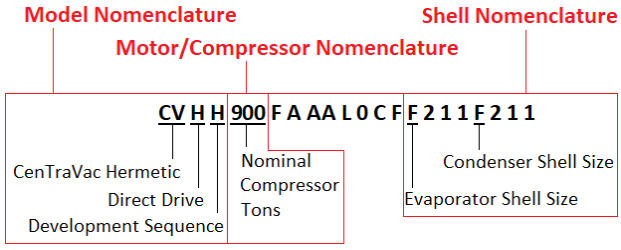
Trane CVHF / CVHH





CVHF Framebreak Estimates at Standard AHRI Conditions				
Compressor	Tonnage Range	Shell Length *	Unit Width	Unit Height
350	300 - 390	11.3 - 15 ft	6.7 - 8.9 ft	8.3 - 9.6 ft
485	350 - 510	11.3 - 15 ft	6.7 - 8.9 ft	8.3 - 9.6 ft
570	400 - 630	11.3 - 15 ft	6.7 - 8.9 ft	8.3 - 9.6 ft
620/650	450 - 710	11.3 - 15 ft	8.1 - 11.1 ft	9.6 - 10.1 ft
760	520 - 830	11.3 - 15 ft	8.1 - 11.1 ft	9.6 - 10.1 ft
870	600 - 950	11.3 - 15 ft	8.1 - 11.1 ft	9.6 - 10.1 ft
910	700 - 1020	11.3 - 15 ft	8.1 - 11.1 ft	9.6 - 10.1 ft
1070	800 - 1150	15 - 16.9 ft	9.9 - 12.8 ft	10.2 - 11.6 ft
1300	900 - 1400	15 - 16.9 ft	9.9 - 12.8 ft	10.2 - 11.6 ft
1470	1050 - 1600	15 - 16.9 ft	9.9 - 13.2 ft	10.9 - 11.9 ft
1720	1300 - 2020	15 - 16.9 ft	9.9 - 13.2 ft	10.9 - 11.9 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.



CVHH Framebreak Estimates at Standard AHRI Conditions				
Compressor	Tonnage Range	Shell Length *	Unit Width	Unit Height
900	850 - 1,000	13.4 - 15.1 ft	9.1 - 13.3 ft	10.1 - 12.1 ft
1000	980 - 1,100	13.4 - 15.1 ft	9.1 - 13.3 ft	10.1 - 12.1 ft
1200	950 - 1,350	13.4 - 15.1 ft	9.1 - 13.3 ft	10.1 - 12.1 ft
1500	1,100 - 1,700	15.1 ft	10.6 - 14.9 ft	11.5 - 12.1 ft
1700	1,400 - 2,020	15.1 ft	10.6 - 14.9 ft	11.5 - 12.1 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Product Overview: **CVHF** and **CVHH** are Trane's flagship water-cooled traditional oiled centrifugal chillers, offered over a wide capacity range (300 – 2,020 Tons for **CVHF** and 850 – 2,020 Tons for **CVHH**). **CVHF** has a fairly high market share in the space, while **CVHH** is newer but still competitive with good market share potential, competing mainly with Daikin's **WSC** product line, while **WDC** and **WCC** compete less often

Design: **CVHF** and **CVHH** are designed around low (negative) pressure refrigerants, but **CVHF** uses R-514A (has high toxicity), while **CVHH** uses R-1233zd(E). Note that **CVHF** does not require ASME code vessels, whereas **CVHH** does require ASME code vessels, therefore **CVHH** will almost always have a higher cost and market price compared to **CVHF**. Both **CVHF** and **CVHH** use 2 stage compressors with 1 refrigerant circuit and a standard economizer

- **(SS)** Specify lower toxicity refrigerants must be used
- **(SS)** Try to ensure Trane is bidding **CVHH** instead of **CVHF** by specifying things like refrigerant usage or other CVHH-specific items to ensure Daikin has a price advantage

Sound: **CVHF's** sound levels range from 75 – 83 dBA, and **CVHH's** sound levels range from 75 – 79 dBA (both are very quiet)

Performance: **CVHF** offers good performance with full load efficiency (0.50 kW/Ton) and part load IPLV (0.32 kW/Ton), and **CVHH** offers good performance with full load efficiency (0.52 kW/Ton) and part load IPLV (0.33 kW/Ton). Additionally, Trane sometimes pushes for 2 GPM/ton Condenser flow rate (standard is 3 GPM/ton) or high lift conditions (85/100 F in Condenser, whereas standard AHRI conditions are 85/95 F)

- **(SS)** Straying away from AHRI conditions benefits Trane's specific two stage compressor design, but it doesn't help the customer long term. Doing a complete system analysis including pumps, cooling tower, and chiller shows that Trane's strategy is flawed – challenge any chiller schedules/specs calling for this type of approach

Starters/Drives: **CVHF** and **CVHH** are offered with refrigerant-cooled or air-cooled unit mounted low voltage VFDs with active harmonic filter (5% THD) for all capacities and fixed speed starters along with VFDs offered in low, medium, and high voltages

Redundancy: **CVHF** and **CVHH** do not offer redundancy, but starting around 1,400 Tons up to 4,050 Tons the "dual **CVHF**" (**CDHF**) and "dual **CVHH**" (**CDHH**) product lines are available

- **(SS)** Pushing your project towards redundancy with dual compressor chillers below 1,400 tons could be a good strategy (**WMC**, **WME**, **WDC**, **WCC**)

Seismic: **CVHF's** seismic certifications are as follows: S_{DS} = 1.16 @ z/h = 1 (roof height) and S_{DS} = 1.86 @ z/h = 0 (ground), and **CVHH's** seismic certifications are as follows: S_{DS} = 1.45 @ z/h = 1 (roof height) and S_{DS} = 2.28 @ z/h = 0 (ground)

Compressor-Motor: **CVHF** and **CVHH** use refrigerant-cooled, semi-hermetic, direct-driven motors and roller bearings which have a finite life expectancy of L10-Rating

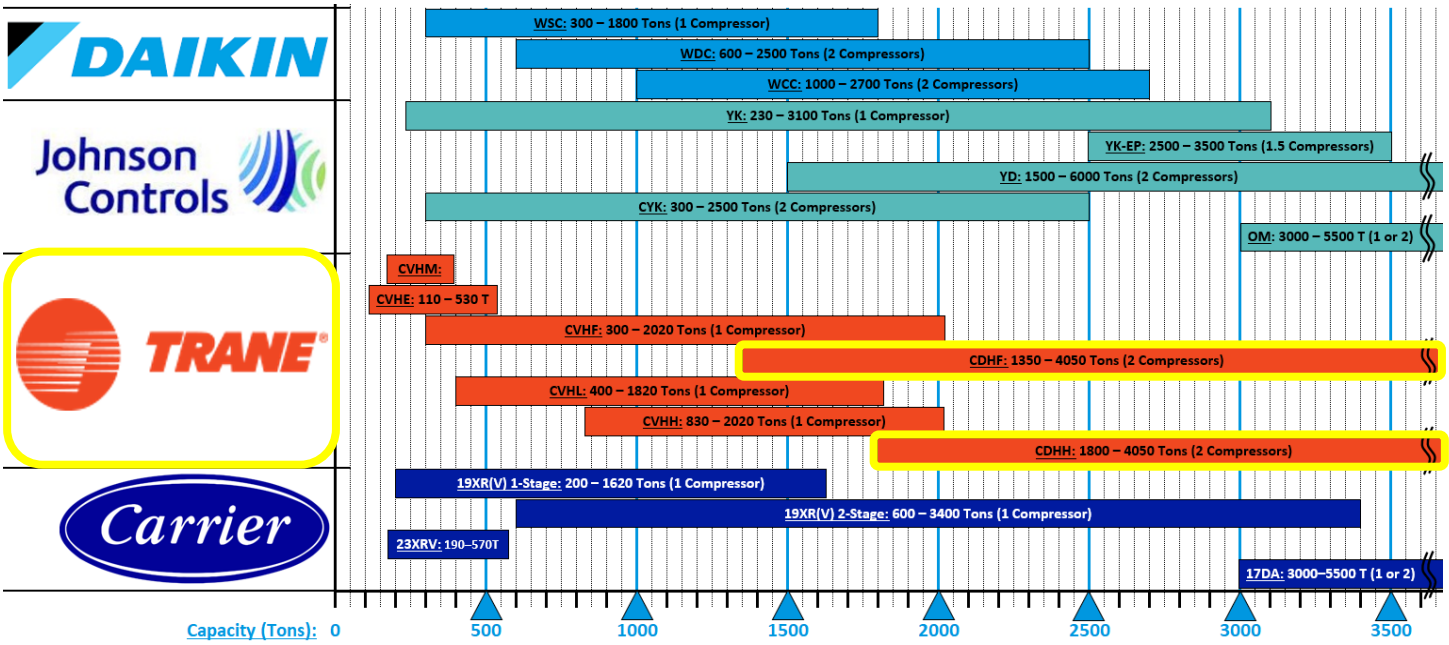
- **(SS)** Specify the use of hydrodynamic bearings (which Daikin uses), or else the manufacturer is to provide lifetime parts and labor for all required periodic bearing maintenance and vibration analysis and report at startup and annually for purpose of trending bearing wear and condition

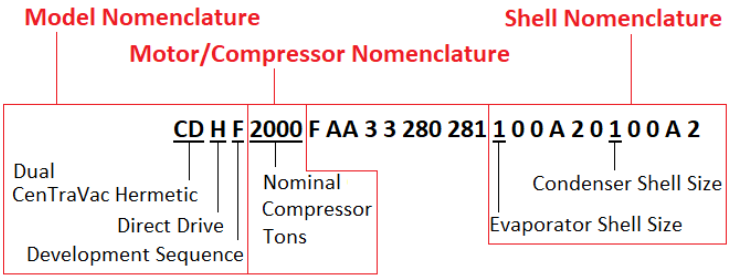
Footprint: **CVHF** and **CVHH** have somewhat compact footprints – Daikin's same capacity **WSC**, **WDC**, and **WCC** chillers are similar or smaller in size

- **(SS)** Highlight the importance of optimizing floorspace at your customer's facility to ensure Daikin has a footprint advantage, especially ideal for retrofit applications

Sales Strategies (labeled as "(SS)" below) are most important to use and communicate before and during bidding

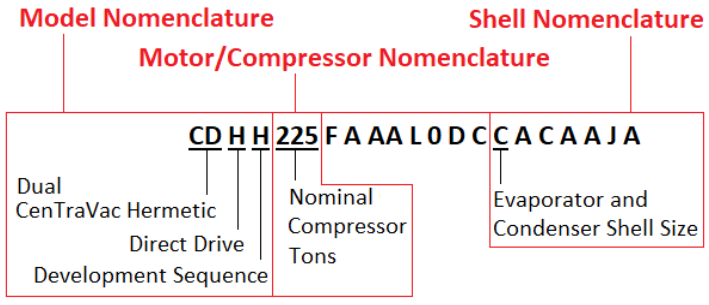
Trane CDHF / CDHH





CDHF Framebreak Estimates at Standard AHRI Conditions				
Compressor	**Tonnage Range**	**Shell Length ***	**Unit Width**	**Unit Height**
1500	1,350 - 1,650	21.5 ft	10.5 - 12.1 ft	11.1 ft
2000	1,500 - 2,100	21.5 ft	10.5 - 12.1 ft	11.1 ft
2170	1,700 - 2,350	21.5 ft	11.4 - 13.2 ft	11.7 ft
2550	1,900 - 2,800	21.5 ft	11.4 - 13.2 ft	11.7 ft
3000	2,100 - 3,300	26 ft	11.4 - 13.2 ft	11.8 ft
3500	2,600 - 4,050	30 ft	11.4 - 13.2 ft	11.8 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.



CDHH Framebreak Estimates at Standard AHRI Conditions				
Compressor	**Tonnage Range**	**Shell Length ***	**Unit Width**	**Unit Height**
2000	1,750 - 2,200	26 ft	11 - 12 ft	11.5 ft
2600	1,900 - 2,900	26 ft	11 - 12 ft	11.5 ft
2800	2,200 - 3,300	26 ft	11.5 - 12.5 ft	11.8 ft
3300	2,900 - 4,050	30 ft	11.5 - 12.5 ft	11.8 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Product Overview: **CDHF** and **CDHH** are both water-cooled traditional oiled dual series counterflow centrifugal chillers – they're essentially a **CVHF** or **CVHH** chiller using two of its identical compressors in a series counterflow unit design, offered over a wide capacity range (1,350 – 4,050 Tons for **CDHF** and 1,750 – 4,050 Tons for **CDHH**). **CDHF** has reasonable market share in the space, while **CDHH** is newer but still competitive with market share potential, competing mainly with Daikin's **WDC** and **WCC** product lines

Design: **CDHF** and **CDHH** are designed around low (negative) pressure refrigerants, but **CDHF** uses R-514A (has high toxicity), while **CDHH** uses R-1233zd(E). Note that **CDHF** does not require ASME code vessels, whereas **CDHH** does require ASME code vessels, therefore **CDHH** will almost always have a higher cost and market price compared to **CDHF**. Both **CDHF** and **CDHH** use 2 stage compressors with 2 refrigerant circuits and a standard economizer

- **(SS)** Specify lower toxicity refrigerants must be used
- **(SS)** Try to ensure Trane is bidding **CDHH** instead of **CDHF** by specifying things like refrigerant usage or other **CDHH**-specific items to ensure Daikin has a price advantage

Sound: **CDHF's** and **CDHH's** sound levels range from 85 – 93 dBA

Performance: **CDHF** offers good performance with full load efficiency of 0.50 kW/Ton and part load IPLV of 0.32 kW/Ton, and **CDHH** offers good performance with full load efficiency of 0.52 kW/Ton and part load IPLV of 0.33 kW/Ton. Additionally, Trane sometimes pushes for 2 GPM/ton Condenser flow rate (standard is 3 GPM/ton) or high lift conditions (85/100 F in Condenser, whereas standard AHRI conditions are 85/95 F)

- **(SS)** Straying away from AHRI conditions benefits Trane's specific two stage compressor design, but it doesn't help the customer long term. Doing a complete system analysis including pumps, cooling tower, and chiller shows that Trane's strategy is flawed – challenge any chiller schedules/specs calling for this type of approach

Starters/Drives: **CDHF** and **CDHH** use a refrigerant-cooled unit mounted low voltage VFD with active harmonic filter (5% THD) and fixed speed starters along with VFDs offered in low, medium, and high voltages

Redundancy: **CDHF** and **CDHH** offer redundancy as standard throughout their capacity ranges

Seismic: **CDHF** and **CDHH** do not offer any seismic certifications: S_{DS} = N/A @ z/h = 1 (roof height) and S_{DS} = N/A @ z/h = 0 (ground)

- **(SS)** Daikin **WSC** and **WDC** chillers are certified to S_{DS} = 1.6 @ z/h = 1 (roof height) and S_{DS} = 1.6 @ z/h = 0 (ground) which is advantageous over **CDHF** and **CDHH** chillers for seismically critical applications or in certain geographic locations. Contact Chiller Applications to discuss seismic specifications before quoting – updated seismic docs can be found at: https://hcai.ca.gov/construction-finance/preapproval-programs/oshpd-special-seismic-certification-preapproval-osp/

Compressor-Motor: **CDHF** and **CDHH** use refrigerant-cooled, semi-hermetic, direct-driven motors and roller bearings which have a finite life expectancy of L10-Rating

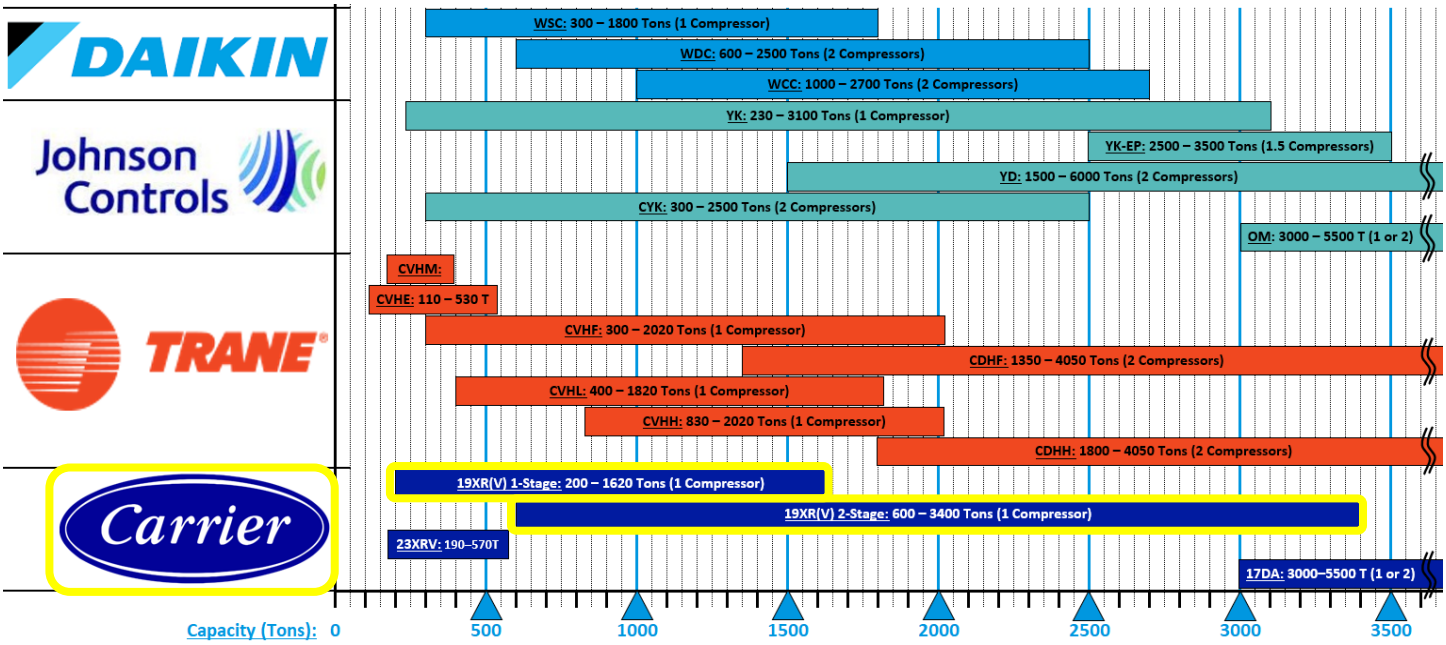
- **(SS)** Specify the use of hydrodynamic bearings (which Daikin uses), or else the manufacturer is to provide lifetime parts and labor for all required periodic bearing maintenance and vibration analysis and report at startup and annually for purpose of trending bearing wear and condition

Footprint: **CDHF** and **CDHH** do not have compact footprints – Daikin's same capacity **WDC** and **WCC** chillers are much smaller in size

- **(SS)** Highlight the importance of optimizing floorspace at your customer's facility to ensure Daikin has a footprint advantage, especially ideal for retrofit applications
- **(SS)** Because of their large unit size and use of a purge unit due to being low pressure machines, these chillers are difficult and labor intensive to service

Sales Strategies (labeled as "(SS)" below) are most important to use and communicate before and during bidding

Carrier 19XR(V) 1-Stage / 19XR(V) 2-Stage



Model Nomenclature — Shell Nomenclature — Motor/Compressor Nomenclature

19XR - 52 51 3 8 H UG T 64 - SINGLE-STAGE

- 19XR: High Efficiency Semi-Hermetic Centrifugal
- -: - = Constant Speed, V = VFD
- 52: Evaporator Shell Size
- 51: Condenser Shell Size
- 3: Compressor Frame Sizes 2, 3, 4, & 5 ONLY

19XR(V) Single-Stage Framebreak Estimates at Standard AHRI Conditions				
Compressor	Tonnage Range	Shell Length *	Unit Width	Unit Height
2	200 - 390	10 - 14 ft	5.1 - 6.8 ft	6.1 - 8.1 ft
3	300 - 580	12 - 14 ft	5.5 - 7.2 ft	6.5 - 9.3 ft
4	500 - 1,010	12 - 14 ft	6.2 - 8.1 ft	6.8 - 10.6 ft
5	770 - 1,620	14 - 16 ft	7.5 - 9.1 ft	6.5 - 11.3 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Model Nomenclature — Shell Nomenclature — Motor/Compressor Nomenclature

19XR - 52 51 C 8 H UG T 64 - TWO-STAGE

- 19XR: High Efficiency Semi-Hermetic Centrifugal
- -: - = Constant Speed, V = VFD
- 52: Evaporator Shell Size
- 51: Condenser Shell Size
- C: Compressor Frame Sizes C & E ONLY

Model Nomenclature — Shell Nomenclature — Motor/Compressor Nomenclature

19XR - A45 A47 6 36 M N 7 - TWO-STAGE

- 19XR: High Efficiency Semi-Hermetic Centrifugal
- -: - = Constant Speed, V = VFD
- A45: Evaporator Shell Size
- A47: Condenser Shell Size
- 6: Compressor Frame Sizes 6 & 7 ONLY

19XR(V) Two-Stage Framebreak Estimates at Standard AHRI Conditions				
Compressor	Tonnage Range	Shell Length *	Unit Width	Unit Height
C	600 - 1,000	12 - 16 ft	6.6 - 9.5 ft	7.6 - 10.4 ft
E	850 - 1,500	14 - 16 ft	7.6 - 10.5 ft	8.5 - 9.9 ft
6	1,400 - 2,250	14 - 18 ft	9.9 - 13.5 ft	9.9 - 12.6 ft
7	2,100 - 3,400	16 - 18 ft	10.1 - 13.5 ft	9.9 - 12.6 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Product Overview: **19XR(V) 1-Stage** and **19XR(V) 2-Stage** are Carrier's flagship water-cooled traditional oiled centrifugal chillers, offered over a wide capacity range (200 – 1,620 Tons for **19XR(V) 1-Stage** and 600 – 3,400 Tons for **19XR(V) 2-Stage**). **19XR(V) 1-Stage** and **19XR(V) 2-Stage** have a low market share in the space, despite being Carrier's main centrifugal offering, competing mainly with Daikin's **WSC** product line, while **WDC** and **WCC** compete less often

Design: **19XR(V) 1-Stage** and **19XR(V) 2-Stage** are designed around medium (positive) pressure refrigerants R-134a and R-513A. **19XR(V) 1-Stage** uses 1 stage compressors with 1 refrigerant circuit and no economizer option, while **19XR(V) 2-Stage** uses 2 stage compressors with 1 refrigerant circuit and a standard economizer

Sound: **19XR(V) 1-Stage's** sound levels range from 86 – 89 dBA, and **19XR(V) 2-Stage** is slightly quieter

Performance: **19XR(V) 1-Stage** offers good performance with full load efficiency of 0.54 kW/Ton and part load IPLV of 0.32 kW/Ton, and **19XR(V) 2-Stage** offers good performance with full load efficiency of 0.53 kW/Ton and part load IPLV of 0.33 kW/Ton

Starters/Drives: **19XR(V) 1-Stage** and **19XR(V) 2-Stage** both use refrigerant-cooled, unit mounted low voltage VFDs with active harmonic filter (5% THD), and fixed speed starters along with VFDs are offered in low, medium, and high voltages

Redundancy: **19XR(V) 1-Stage** and **19XR(V) 2-Stage** do not offer redundancy

- **(SS)** Pushing your project towards redundancy with dual compressor chillers could be a good strategy (**WMC**, **WME**, **WDC**, **WCC**)

Seismic: **19XR(V) 1-Stage** and **19XR(V) 2-Stage** do not offer any seismic certifications: S_{DS} = N/A @ z/h = 1 (roof height) and S_{DS} = N/A @ z/h = 0 (ground)

- **(SS)** Daikin **WSC** and **WDC** chillers are certified to S_{DS} = 1.6 @ z/h = 1 (roof height) and S_{DS} = 1.6 @ z/h = 0 (ground) which is advantageous over **19XR(V) 1-Stage** and **19XR(V) 2-Stage** chillers for seismically critical applications or in certain geographic locations. Contact Chiller Applications to discuss seismic specifications before quoting – updated seismic docs can be found at: https://hcai.ca.gov/construction-finance/preapproval-programs/oshpd-special-seismic-certification-preapproval-osp/

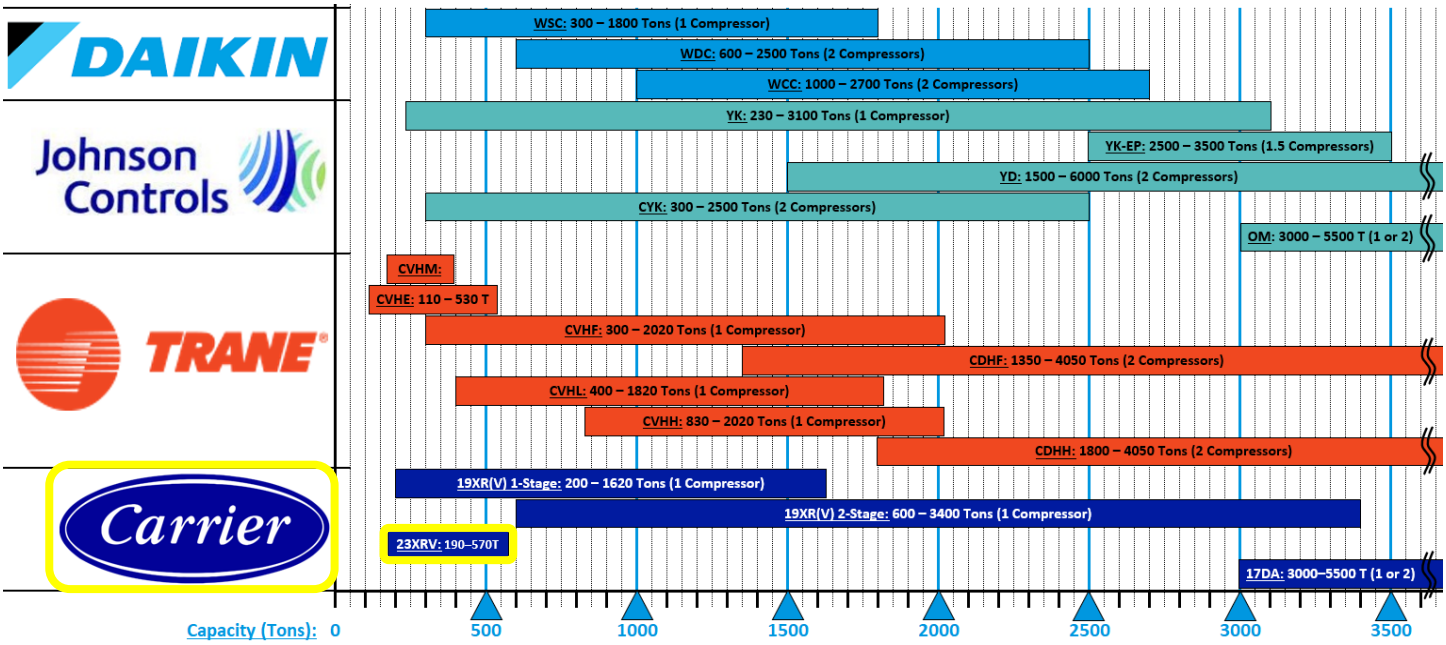
Compressor-Motor: **19XR(V) 1-Stage** and **19XR(V) 2-Stage** use a refrigerant-cooled, semi-hermetic, gear-driven motor

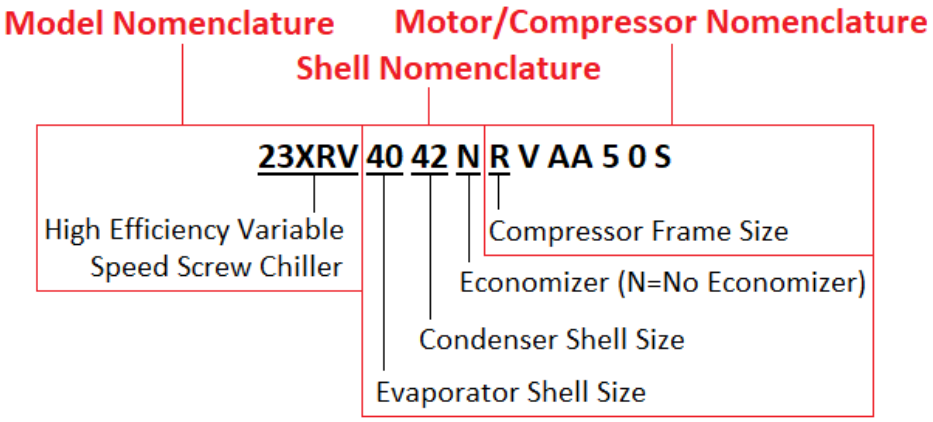
Footprint: **19XR(V) 1-Stage** and **19XR(V) 2-Stage** have a somewhat compact footprint – Daikin's same capacity **WSC**, **WDC**, and **WCC** chillers are similar in size

- **(SS)** Highlight the importance of optimizing floorspace at your customer's facility to ensure Daikin has a footprint advantage, especially ideal for retrofit applications

Sales Strategies (labeled as "(SS)" below) are most important to use and communicate before and during bidding

Carrier 23XRV





23XRV Framebreak Estimates at Standard AHRI Conditions				
Compressor	**Tonnage Range**	**Shell Length ***	**Unit Width**	**Unit Height**
P	190 - 320	12 - 14 ft	3.2 - 4.9 ft	7.1 - 10.3 ft
Q	250 - 400	12 - 14 ft	5.5 - 7.2 ft	7.1 - 10.3 ft
R	360 - 570	12 - 14 ft	5.5 - 7.2 ft	7.1 - 10.3 ft

* Shell Length is the length of the vessel without the waterboxes/nozzles on each end.

Product Overview: **23XRV** is the only non-centrifugal product (using a screw compressor) that competes with other centrifugal chillers in the market and is Carrier's best-selling water-cooled product line, offered over a small capacity range (190 – 570 Tons). **23XRV** is sometimes seen in the market competing with centrifugals, but doesn't have a high market share, competing mainly with Daikin's **WSC** product line, while **WMC** and **WME** compete less often

- **(SS)** Specify centrifugal compressor technology only, not allowing screw compressor chillers to bid
- **(SS)** See Magnitude Playbook for details on competing against **23XRV** with Daikin's mag bearing products

Design: **23XRV** is designed around medium (positive) pressure refrigerant R-134a, using a positive displacement screw compressor with 1 refrigerant circuit and an optional economizer

- **(SS)** Screw compressors use roller bearing technology with a finite bearing life rating of L10 – this means expensive compressor rebuilds at a minimum cost of $50,000 dollars. Specify hydrodynamic bearings which have effectively infinite life, or else Carrier must provide lifetime parts and labor for all required periodic bearing maintenance and vibration analysis and report at startup/annually for trending bearing condition/wear

Sound: **23XRV** sound levels range from 83 – 86 dBA

Performance: **23XRV** offers great performance with full load efficiency (0.53 kW/Ton) and part load IPLV (0.30 kW/Ton)

Starters/Drives: **23XRV** uses an air-cooled unit mounted low voltage VFD with active harmonic filter (5% THD) up to 320 Tons and refrigerant-cooled unit mounted low voltage VFD with active harmonic filter (5% THD) from 250 to 570 Tons

Redundancy: No redundancy offered on the **23XRV** platform

- **(SS)** Pushing your project towards redundancy with dual compressor chillers could be a good strategy (**WMC**)

Seismic: **23XRV's** seismic certifications are as follows: S_{DS} = 2.0 @ z/h = 1 (roof height) and S_{DS} = 2.5 @ z/h = 0 (ground)

Compressor-Motor: **23XRV** uses a semi-hermetic, direct-driven motor with oiled tri-rotor steel ball bearings that requires 10 gallons of HAZMAT per compressor to operate

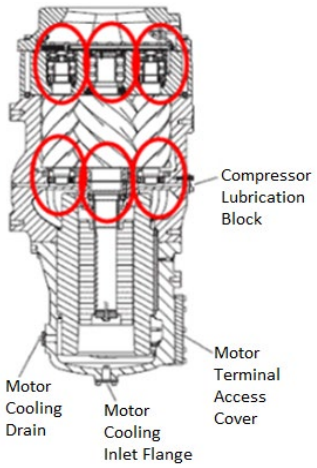
- **(SS)** Very high oil maintenance required (the word "oil" is mentioned over 600 times in their Operation and Maintenance manual) per below screenshot of their own literature:

Changing Oil and Oil Filter (p. 73) — *"If the OIL PRESSURE DELTA P approaches the 18 psid (124 kPad) LOW OIL PRESSURE ALARM threshold, change oil filter as needed. Otherwise, change the oil filter on a yearly basis. Change the oil after the first year of operation. Then, change the oil at least every three years, or as needed. However, if a continuous oil monitoring system is present and/or a yearly oil analysis is performed, the time between oil changes may be extended."*

Oil Heater (p. 74) — *"Inspect the oil heater for carbon build-up on the heating element if an adequate oil sump temperature cannot be maintained when the chiller is shut down. It may be necessary to temporarily install the heater element terminal cover to provide additional leverage while threading the oil heater into the sump. The sump oil heater elements must be positioned vertically to allow proper heat convection. See Fig 43 and 44."*

Compressor Bearing Maintenance (p. 77) — *"The compressor bearings are designed to last for the life of the chiller. The key to good bearing maintenance is proper lubrication. Use the proper grade of oil, maintained at recommended level, temperature, and pressure. Inspect the lubrication system regularly and thoroughly. Excessive bearing wear can be detected through increased vibration. If this symptom appears, contact an experienced and responsible service organization to perform vibration analysis on the compressor."*

Compressor Rotor Check (p. 77) — *"Use Carrier specified oil. Excessive compressor rotor wear is shown by a lack of performance. If a lack of performance is noted, have the compressor rotors inspected by a trained service person. The rotors can be visually inspected once every 5 to 10 years or as needed depending on chiller operating conditions."*



Footprint: **23XRV** has a somewhat compact footprint – Daikin's same capacity **WSC** chillers are similar or smaller in size (Magnitude **WMC** and **WME** chillers are smaller in size)

- **(SS)** Highlight the importance of optimizing floorspace at your customer's facility to ensure Daikin has a footprint advantage, especially ideal for retrofit applications